MANUALS OF HEALTH

FOOD.

ALBERT. J. BERNAYS

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BY

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The favour with which a work of mine on Household Chemistry was received in 1851, both by the Press and the Public, is sufficient evidence that there was a demand for a work of the kind. The titles of the several chapters were imitated from the late Professor Liebig's Chemistry of Food.

The sixth edition of my book was printed in 1867; in the seventh edition I dropped the articles on food.

The present volume is largely based upon my Household Chemistry, supplemented by increased experience, both analytically and otherwise.

CONTENTS.

ON FOOD.

CHAPTER I.

WATER AS AN ARTICLE OF FOOD.

1. The influence of food cannot be understood without reference to water and its effects upon the body. Water forms about 79 parts out of 100 of the weight of the blood, and is necessary for the carrying of the food from one part of the body to another. The further necessity for water is shown by the fact that a fullgrown man loses daily about eighty-four ounces, one-half of which is given off by the skin and lungs.

2. The water thus lost by perspiration and otherwise has, of course, to be replaced from without. Now, the skin has a certain, though very limited, power of absorbing moisture. Dr. Madden found that a man in a warm bath absorbed about one ounce and a half of water in half an hour. If the fluid of the body has been previously diminished by exhalation, the absorption is much more active. A man who had lost three pounds by perspiration, during one and a half hour's labour in a dry atmosphere, regained eight ounces in a warm bath in half an hour. This absorbent power of the skin may occasionally be turned to account. Thus, a patient, who was quite unable to take food, has been kept alive by baths of milk and water.

3. The skin has a very important duty to perform,

on which health is greatly dependent. This duty is the throwing off of perspiration, and is brought about by the little tubes or "pores" existing in every part of the skin. Commencing at the surface, the tubes pass inwards, twisted like a corkscrew, to the underside of the true skin, where they end in little balls or glands, in which the perspiratory material is formed. The number of these pores is so great that 3,528 have been counted in a square inch on the palm of the hand. Assuming each of these pores to be a quarter of an inch in length, and the surface of the body of a man to contain 2,500 square inches, the number of pores has been calculated at seven millions, and their length nearly 28 miles! This length of drainage, this breathing from the skin, is one of the ordained means of throwing off waste material which would be injurious to the body, and for keeping it at an equal temperature. The simplest and best means of preserving the skin in health is by bathing and washing with soap and water, and rubbing with a rough towel.

4. Every one knows the effect of a "close" day, although he may not know the cause. It is simply due to the fact that the air has taken up as much moisture as it can hold, when it is said to be saturated: we then find it difficult to get rid of our own moisture. On the other hand, a dry atmosphere parches the surfaces both of the skin and lungs, and often brings about a chill, owing to the rapid evaporation.

5. As a rule, the amount of water contained in any tissue is in proportion to its vital activity. For instance, the brain, nerves, and muscles are watery in comparison to bones, skin, nails, and hair. In vegetables we observe the same facts: any portions that have left off playing an active part in growth or in nourishment, become hard and solid, like the heart-

wood in trees; and yet we find many vegetables that can bear the loss of their water, either in part or wholly, without being killed. Mosses have been kept dry for years, and yet have lived again under the freshening influence of water. The long sleep of corn seeds for many hundreds of years in mummies, and their germination by heat and moisture, is an instance of the same kind. And even more striking still, because occurring in a more highly organized plant, is the drying up of the beautiful rose of Jericho; when it is parched by the burning sun, it contracts into a ball, and in that state is wafted hither and thither by the winds, till some friendly moisture again tempts it to expand its leaves and rose-like flowers. Such examples show the necessity of water for anything like vital activity, though life may be sustained, for a time at least, without it.

6. **Water forms a large proportion of our food,** as may be seen by the following Table :—

Mushrooms	96·0	Lean beef and mutton	72·0
Cabbages	92·0	Greengages	71·0
Beer and ale	91·0	Tripe	68·0
Green-top turnips	90·0	Cream	66·0
Carrots	87·6	Veal	63·0
Milk	87·5	Sweet potatoes	59·0
Beetroot, Champignons	87·0	Pork fat	39·5
Kohlrabi	86·0	Wheaten bread, crust and crumb	38·0
White Swede turnips	85·0	Kidney-beans, Treacle	23·0
Pears	84·0	Arrowroot	18·0
Currants	81·5	Haricots	16·0
Peaches	80·2	Flour and oatmeal	15·0
Artichokes	79·0	Peas	13·0
Fish	78·0	Rice	12·5
Salmon	77·0	Lentils	12·0
Potatoes, Cherries and apricots	75·0	Butter	7·0
Ox-liver, Eggs	74·0	Indian corn or maize	6·0

7. Water never occurs in Nature without containing certain **gases** and **salts**: it is Nature's great solvent. According to the absence or presence of certain salts, water is either **soft** or **hard**. For cooking it is impossible to employ too soft a water, especially as regards salts of lime and magnesia (par. 11), such a one as but slightly curdles soap.

8. Mere **clearness**, or, in other words, perfect transparency, although an essential of good drinking-water, is **no proof** of **purity**; and it should also be remembered that ordinary filtration cannot remove dissolved impurities. The qualifications of a good drinking-water are peculiar, but may be discerned. If a careful examination be made of the sap of young vegetables, it will be found that only a soft water, containing but small amounts of salts of the metals potassium, sodium, calcium, and magnesium, is present. Also, if inquiry be made into the habits of cattle, it will be found that, where they can choose for themselves, they will select that water which, having no fault on the score of clearness, is soft, and therefore but slightly curdles soap. For what is the object of the water we drink? Partly to act as a carrier by which fresh supplies of food are introduced into the body, and its used-up materials removed; partly to enter bodily into the construction of the tissues. As food should be cooked with especial reference to its digestibility, or, in other words, to its solubility, so the water we drink should be comparatively soft, as then its solvent powers are greatest.

9. **Water**, to be **good** for **drinking**, should be bright and clear as crystal, when poured into a tumbler. Both **oxygen** and **carbonic acid gas** should be present in solution, and, for this reason, water should not be allowed to stand long in a warm room, nor in sunlight, nor be drawn long before it is wanted. It should also be cool, and possess no decided taste.

The best drinking-waters are those from various German mineral springs. Not only are they very refreshing, but they are free from the various contaminations which are so universal in all our English river-waters, and which render them unfit for drinking in times of epidemics.

10. If a person has a tendency to become stout, he should restrict himself in the use of water, as indeed in the use of drinks of all kinds. But, if the body is broken down by excesses of any kind, the copious use of soft water, externally and internally, under proper medical treatment, is strongly recommended.

11. The presence of **salts of lime** detracts materially from the value of water for **cooking purposes.** The great disadvantage is this; that, when it boils, just when the vegetable is beginning to be thoroughly penetrated by it, suddenly there is a plentiful separation of **carbonate of lime** (a kind of chalk) in every pore. The vegetable is thus hardened by it, instead of being rendered soft and succulent, and the chalk, having found a congenial resting-place, will not be disturbed by any amount of boiling, however long continued. Such water is said to be temporarily hard. One piece of advice can be given: such water can be **softened by boiling,** and, in such a case, water from the boiler, in which the water has been boiled for at least a quarter of an hour, should be used for cooking; otherwise the vegetables should be steamed and not be brought into actual contact with the water.

12. The insides of kettles and boilers used for boiling water, should from time to time be examined, as of course, the salts which are separated, collect at the bottom and form a **crust or fur.** As this crust is a very bad conductor of heat, it retards greatly the act of boiling.

Such springs as deposit carbonate of lime are often known as "petrifying wells." In Italy, a building-stone in common use, known as "Travertine," and composed altogether of carbonate of lime, is deposited from "volcanic waters." An example occurs in a lake existing in the Campagna of Rome, at a spot on which the Romans erected baths. "Reeds, lichens, confervæ, and a vast mass of aquatic vegetation," says Sir H. Davy, "here find a rich repast, and grow in the utmost luxuriance, forming a number of floating islands on its surface" (fig. 1).

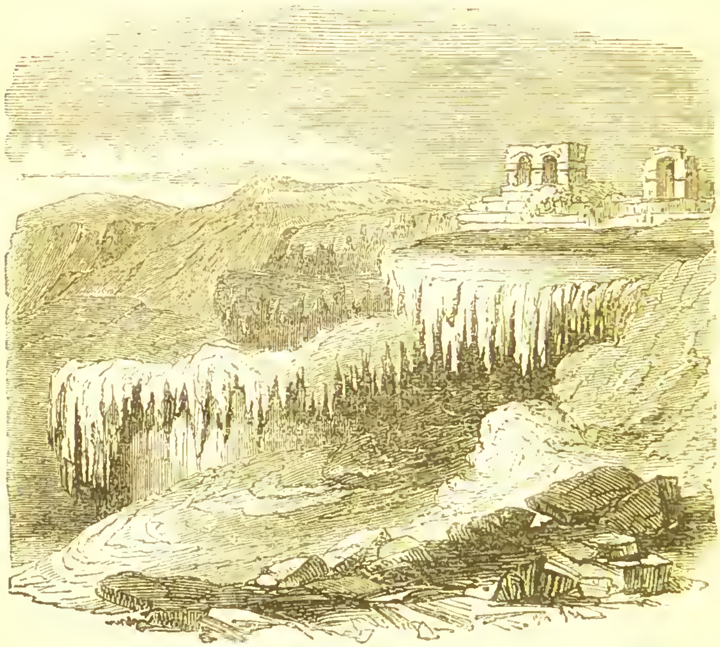


Fig. 1.

13. It is worthy of remark that one, at least, of the salts combined in water, viz. chloride of sodium

(common salt), is of essential service to digestion. For, not only is this the source partially of the gastric juice, but it is itself a powerful solvent of albumen.* So necessary is salt to health, and especially to the young, that all vegetables should be strewn with salt before they are cooked or steamed. It should not be left to choice whether our children eat salt, or not.

14. The impurities of vegetable and animal origin in water—the so-called **organic impurities**—are of serious importance, as these are they which often set up changes in the blood. When present, even in minutest quantities, they render water totally unfit for drinking. Now, next to long-continued boiling, and in some cases in addition to it, there are few better, and certainly no pleasanter, purifiers of such water than toast. The freshly-made carbon on its surface is but little inferior to animal charcoal. The toast should be thin and crisp, and toasted externally almost to charring; the resulting **toast-and-water** (made with boiling water), will then be of a bright amber-colour, and perfectly clear.

15. One piece of advice may be given with reference to **tap-waters**. The water should be allowed to run to waste for the space of a minute, before any is drawn for use. Thus, whatever may have collected in the pipes will be effectually discharged. Of course the **cisterns** should be **cleansed** every three or four months, as the chief sources of impurity will be found in them. But the sooner the intermittent supply of water in towns ceases, the better.

16. Water, especially when made cheering by **carbonic acid** gas, as is the case with many mineral waters, is the only natural quencher of thirst. Though dependent, of course, on the deficiency of

* White of egg is the typical form of albumen.

water in the body generally, thirst is produced directly by an impression on the nerves of the stomach and throat. Hence it may be satisfied, for a time at least, by a counter-impression on these nerves. On a long summer's walk, there is no better drink than water, and the practice of quenching the thirst in warm climates, by alcoholic drinks, is worse than useless.

17. Water is a compound of two elements, **Hydrogen** and **Oxygen**; it is an **oxide of hydrogen.**

Now hydrogen is most easily prepared from its **oxide, water.** If water be boiled in the retort *a*, fig. 2,

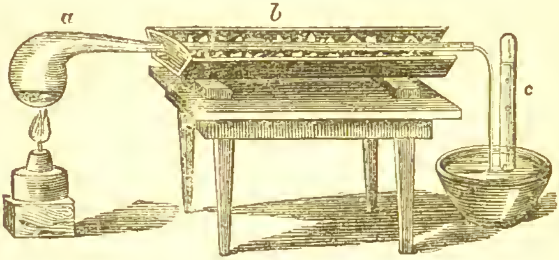


Fig. 2.

and its steam passed over red-hot iron-filings contained in the gun-barrel *b*, hydrogen passes over, and may be collected in the tube *c*, inverted over water. The iron at a red heat takes the oxygen, and becomes oxide of iron: hydrogen is set free as a colourless gas, which burns in air with a pale flame, and becomes again hydrogen oxide, or water. The composition of water may be shown by experiment. "If the two poles of a galvanic battery, terminating in platinum ends, be plunged into water (acidulated with about one-third of hydrogen sulphate, so as to make it a better conductor of electricity), bubbles of gas are seen to arise

at each pole or wire. If these gases are collected, by placing tubes filled with the same acidulated water (fig. 3) on the ends of each pole, twice as much gas will be found in one tube as in the other. At the positive (+) pole, oxygen is collected; at the negative (−) hydrogen, the latter being in amount double that of the former. This experiment shows water to be a compound of two volumes of hydrogen and one volume of oxygen." (See "Chemistry," in the Manuals of elementary Science, published by the Society for Promoting Christian Knowledge.)

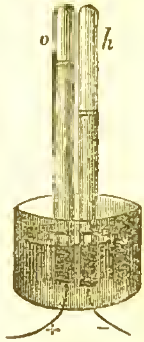


Fig. 3.

18. Water boils at a temperature of 100° Centigrade, or 212° Fahrenheit. When the steam has an elastic force just sufficient to balance and overcome the pressure of the air upon its surface, the water from which the steam rises is said to boil. The temperature of boiling water is a fixed point, and has been adopted as such in all thermometers. And here another fact meets us, which is well worthy of observation, and especially to those to whom the cost of a fire is of importance. It does not matter, except as regards waste, how fierce the fire may be under the kettle or other vessel in which the water may be heated,—it can but boil. When once water boils, it requires but a very small fire to keep it boiling, or on the boil. In the open air, the boiling point cannot be raised, because the pressure of the atmosphere cannot be increased. But, if water be boiled in a close vessel, as in the boiler of the steam-engine, the steam which is produced, having no means of escape until it can lift a certain weight, and continually increasing in quantity, gradually raises the pressure more and more to any

point that may be desired; and, with the pressure, the temperature. Now the steam which rises from the water under pressure is called **high-pressure steam.**

19. Temperature and pressure are, indeed, in such close relationship, that one might judge of the pressure by the thermometer. The temperature of the steam is always the same as that of the water from which it rises. Advantage i frequently taken of this fact, when a steady temperature above 100°C. is required. It is turned to account in **Papin's digester,** so much used in the making of soups, and in the extraction of gelatin from bones. This consists of a strong iron saucepan, the lid of which is supplied with a safety-valve, by which the pressure of steam can be regulated, and the vessel prevented from blowing up. Some such apparatus becomes absolutely necessary to persons living on high mountains, as the temperature at which the water there boils is too low for common cooking purposes.

CHAPTER II.

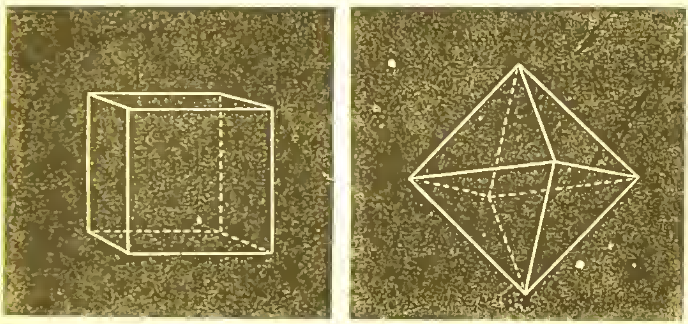
STARCHES OF DIFFERENT KINDS.

20. Enough will have been said to show the importance of water. To those who have been prepared for the study of food by an elementary course of chemistry, it will be no new information to be told that many articles of daily food **contain** hydrogen and oxygen, **not as water,** but in the same **proportions** as we find

them in water. [WATER is HYDROGEN OXIDE, H_2O; in it the hydrogen is already completely oxidized, or burnt; for which reason water can be employed for putting out a fire.]

21. The various STARCHES and SUGARS afford good illustrations of bodies which consist of **carbon** and the **elements of water**; the latter in the proportion of **two** atoms of hydrogen to every **one** of oxygen.

Carbon has been already mentioned in carbonic acid, a chemical compound of carbon with oxygen. It is an element, best represented in the **diamond**, which is found crystallized in regular forms, all derived from the cube (fig. 4), or the octahedron (fig. 5). Carbon also



Figs. 4 and 5.

occurs as **graphite**; but it is rather in the variety of carbon known as **charcoal** that carbon would be separated from a lump of sugar by burning. A piece of wood is known to char, or blacken, when strongly heated; and so also do sugar, starch, and such-like foods. In toasting, for making toast-and-water, we char the bread; in fact, produce a surface-charcoal. Thus we may also char meat, when we say it is burnt, because meat contains carbon.

22. Just as a piece of charcoal requires to be heated

to redness before it will burn in oxygen, so it must be understood, that all the varieties of food mentioned in this chapter contain in themselves **none** of the **necessary oxygen** for the **combustion** of the **carbon.** And just as heat is produced in a fireplace by the burning or oxidation of charcoal, so likewise is heat produced in the human body by the burning of the carbon of the sugars and starches.

23. It must not be thought necessary that a body should actually burn before it can give off heat. We may have **true combustion,** attended **with heat,** but **without light.** In fact the heat of the body is kept up principally by the union of the oxygen of the air with the carbon and the hydrogen of our food. The carbon unites with oxygen to form carbonic acid, and the hydrogen with oxygen to form water.

24. A full-grown healthy man **emits** $8\frac{1}{2}$ **ounces of carbon** daily from his **lungs**; not as carbon, but oxydized, as carbonic acid. By the oxygen of the air, every time a breath is drawn, a portion of the carbon of the blood becomes **carbonic acid.** Breathed air contains one hundred times as much carbonic acid as the fresh air before it is breathed. This breathed air will neither support combustion, nor serve any longer for respiration. If we breathe through a glass tube into a bottle containing lime-water (made by shaking a little slaked lime with water, and pouring off, after settlement, the clear fluid), the latter becomes milky from the formation of carbonate of lime, or chalk. The act is represented in fig. 6. Now air in its ordinary condition would not produce this change, on account of the exceedingly small quantity of carbonic acid contained in it. Thus is a certain portion of air spoilt by every breath drawn.

[Twelve parts by weight of carbon unite with thirty-two parts by weight of oxygen, to form forty-four

parts by weight of carbonic acid. CARBONIC ACID, a compound of one atom of carbon with two atoms of oxygen, is represented by the symbol CO_2.]

25. **Not** that the starches (and sugars) are **alone** of use **in keeping** up the **heat** of the body (animal heat), though this is their chief function. They are also concerned in the **production of fat**; and from this fact we obtain a hint to be moderate in the use of such foods, if we are naturally inclined to stoutness.

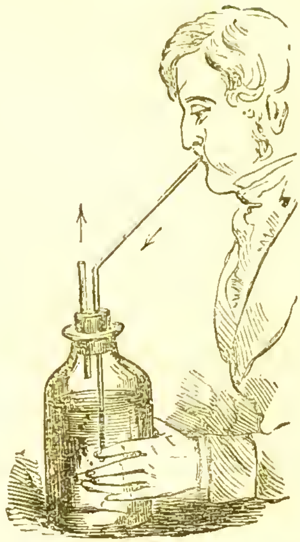


Fig. 6.

26. Next to wood, **starch** is the most abundant product of the vegetable kingdom. The seeds of the various grasses contain it largely, as do also those of peas,

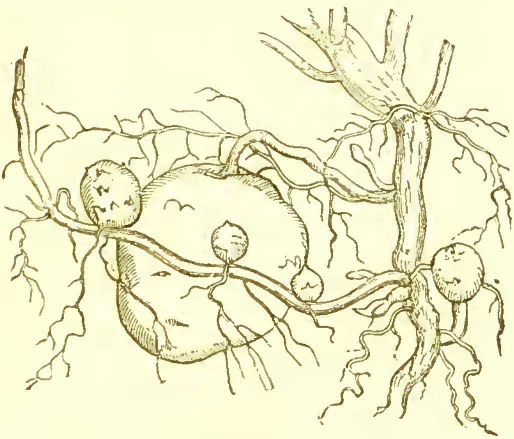


Fig. 7. Tubers of the Common Potato.

beans, lentils, &c. It is abundant in the tubers of the potato (fig. 7), and in the roots of tapioca and of arrowroot. Fig. 8 represents a cell of the potato containing starch-granules; fig. 9 potato-starch. The compound starch-granules of West India arrowroot are pictured in fig. 10; wheat-starch in fig. 11; and rice-starch in fig. 12.

Fig. 8.

Fig. 9.

As the reader may judge, the starch granules vary much in size and form; so much so, indeed, that in the different species of plants they may be distinguished by a

Fig. 10.

Fig. 11.

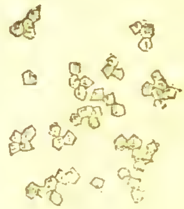


Fig. 12.

practised eye with the aid of a microscope. The illustrations are taken from Professor Bentley's "Manual of Botany," and are supposed to be magnified 250 diameters. The largest granules of starch are those of tous les mois, where they are sometimes $\frac{1}{200}$ of an inch in length, while the smallest granules, like those of rice, are often less than $\frac{1}{5000}$ of an inch in length.

27. The properties of starch are mainly these. It forms a white glistening powder, heavier than, and perfectly insoluble in, cold water. At a temperature of 60° C. it begins to change; the starch-grain swells up when thus heated with water, and produces the

well-known condition of "paste," so much used for stiffening linen, and so often witnessed in sodden potatoes. As usually sold in the shops, although so dry in appearance, starch holds 18 per cent. of water. When **heated by itself**, it undergoes a very remarkable change, and becomes so perfectly soluble in water that it has obtained the name of **British gum** (par. 28), because so closely resembling gum in appearance and properties. All the methods employed in the preparation of starch, depend upon its insolubility in cold water. Starch is manufactured from potatoes (which contain about 20 per cent.), by rasping the well-washed tubers, receiving the pulp upon a sieve, and washing with water as long as the latter appears milky. The starch soon settles, is repeatedly washed, drained in baskets lined with ticking, placed upon unglazed tiles, and lastly dried.

Of all grains, **rice** contains the largest amount of starch (fig. 12), and from it large quantities are prepared. On a small scale, starch may be obtained from wheaten flour by mixing it up into a paste with water, and washing it, enclosed in a muslin bag, in a stream of water; a milky fluid passes through, which, when set aside, deposits the starch as a white powder.

The per-centage of starch in various articles of food may be understood from the following table:—

Arrowroot	82·0	Peas	55·0
Rice	80·0	Wheaten bread	47·0
Millet	74·0	Lentils	40·0
Barley-meal	70·0	Potatoes	20·0
Wheaten flour	66·0	Parsnips	9·0
Maize	65·0	Carrots	8·0
Oatmeal	59·0	Turnips	5·0

From whatever source derived, starch has the same chemical composition. It consists of carbon, hydrogen,

and oxygen. [STARCH, $C_{12}H_{20}O_{10}$, contains twelve atoms of carbon, united to the elements of water in the proportion of ten atoms. It can only supply these three elements.] The starches are, however, of very different degrees of digestibility, the genuine arrow-roots being the most digestible. **Arrowroot**, which derives its name from the root of the **Maranta arundinacea**, owing to its supposed efficacy in counteracting the effects of wounds caused by poisoned **arrows**, is extracted by a mechanical process from the roots when about ten or twelve months old. In Bermuda, the roots are first deprived of their paper-like scales, and then ground by a kind of wheel-rasp. The pulp is thrown into clean water, and stirred about to separate the fibrous parts, which are collected in the hand. The milky liquor which remains is poured through a sieve, and afterwards allowed to settle for some time. The arrowroot sinks to the bottom, and when the water is poured off, the white pasty mass that remains, is placed on clean white cloths to dry in the sun. It is then fit for use. When pure it has a dull and opake-white colour, and crackles when pressed between the fingers. The starch-granules in arrowroot (fig. 13) are much larger than those of wheaten flour;

Fig. 13. Fig. 15. Fig. 14.

West India Arrowroot and Sago Meal,
both magnified 250 diameters.

they do not, however, exceed $\frac{1}{600}$ of an inch in diameter. Canna, or **tous les mois**, is another variety of arrowroot, the starch-granules of which are no less than $\frac{1}{260}$ of an inch in diameter (fig. 14). There are also various kinds of spurious arrowroot in the market; many of the so-called genuine kinds are made from, or largely adulterated with, potato-starch; and although not unwholesome, are neither so digestible nor even so nutritious—if such a word can be applied to either sort. Nevertheless, when made up with milk (par. 118), arrowroot forms a light, palatable, and highly serviceable diet for invalids.

The **Manihot utilissima**, which is found in South America, has very large roots rich in starch, from which **Tapioca** and **Cassava** are obtained. Tapioca differs from cassava only in being a purer kind of starch; the latter, however, is somewhat more nutritious, because it contains a somewhat larger proportion of the element nitrogen (par. 105). Among the Indians cassava supplies the place of bread. The roots are scraped on a sort of rasp, formed of small fragments of flint stuck into a plank; the pulp is put to drain in a long strainer made of the bark of a species of fig; the juice having drained away, water is added to finish the washing; the liquid comes out nearly clear, and without bringing away any perceptible quantity of starch. To form the pulp into cakes of cassava, it is spread out on an earthen dish placed over the fire, the process being complete when the cassava is dry and slightly toasted on the outside.

Sago is the starch obtained from the pith of the sago palm, by making it into a paste with water, and pressing the mixture through a perforated metallic plate; the little cylinders thus obtained are granulated by placing them in a revolving vessel; these are then exposed upon a sieve to a jet of steam, and

[illegible]

subsequently dried. Fig. 15 represents sago meal magnified 250 diameters.

28. The conversion of starch into a sort of gum has been already alluded to (par. 27, p. 21). **Dextrin**, as it is called, is a transparent brittle solid, very soluble in water, and with adhesive properties resembling gum-arabic. It is made on a large scale by heating starch at a temperature of 200° C., and is produced in small quantities in the baking and toasting of bread. [DEXTRIN, $C_{12}H_{20}O_{10}$, does not differ from starch in chemical composition, but consists of carbon and the elements of water.]

29. The groundwork of all plants is made up of **cellular tissue**, of which the best idea can be obtained by a short description of the meaning. It occurs nearly pure in cotton, linen, and pith; in such condition it is a white, tasteless substance, perfectly insoluble in water, alcohol, and ether, and is better known by the name of **Cellulose**. In the turnip and the potato, as well as in young asparagus, and such-like juicy vegetables, cellulose is loose, succulent, and nearly as digestible as starch, whilst in such fibres as hemp and flax it is hard and indigestible. Cellulose, indeed, passes almost imperceptibly into wood, as we remark when a young vegetable becomes tough and stringy with age. How closely cellulose and starch agree chemically may be learnt from the composition, in 100 parts, of starch, and the cellular tissue of an apple, and a mushroom.

	Starch.	Cellulose.	
	Rice.	Apple.	Mushroom.
Carbon	44·9	44·7	44·5
Hydrogen	6·3	6·1	6·7
Oxygen	48·8	49·2	48·8
	100	100	100

[CELLULOSE, $C_{18}H_{30}O_{15}$, is evidently produced from starch, and, like the latter, is a compound of carbon and the elements of water. When burnt in oxygen, it is changed into carbonic acid and water.]

30. Yet another principle, which, like starch and cellulose, extensively pervades the vegetable kingdom, is the substance which gives to many fruits and vegetables the power of forming a jelly. It is known to chemists by the name of **pectin**, and contains, in somewhat different proportions, the same elements—carbon hydrogen, and oxygen.

31. PECTIN must not be confounded with **gum**, which is found in the juices of almost all plants, but is met with in its purest form in gum-arabic; nor must gum, or **arabin**, as it is called, be mistaken for **mucilage**, which is insoluble in water. Many seeds furnish mucilage largely; such as linseed, quince-seed; and roots, such as the marsh-mallow: when moistened with water, mucilage swells up into a gelatinous mass. In chemical composition, mucilage is identical with starch, and arabin with cane-sugar. Both of them consist of carbon and the elements of water.

32. Whether then we speak of STARCH or DEXTRIN, of CELLULOSE or PECTIN, of ARABIN or MUCILAGE, they all belong to that class of foods known as **carbonaceous. They consist only of carbon, hydrogen, and oxygen.**

CHAPTER III.

THE SUGARS.

33. THE sugars are so closely related to the starches, and so nearly resemble them in chemical

composition, that the consideration of them in consecutive chapters seems the most natural treatment. Whether we speak of the sugar of the sugar-cane, or the sugar of the grape, or the sugar of milk, they **all belong to** the **carbonaceous class of foods.**

34. The sugar-cane is the chief source of the sugar consumed among ourselves, as the beet-root is of that among the French and Germans. **Saccharum officinarum**, as the botanists call the sugar-cane, belongs to the large family of the **Gramineæ**, or **Grasses**. It is cultivated largely in the West India Islands, Guiana and the Brazils, as also in the Mauritius, Bourbon, Java, the Philippine Islands, &c. It presents the appearance of a solid jointed reed, like a gigantic grass, and grows to a height of eight feet or more, varying according to soil and climate. The canes are cut before they flower, and as close to the ground as possible, as the lowest joints contain the most sugar. Immediately after cutting, the ripe canes are stripped of their leaves, and pressed between grooved iron cylinders. To prevent the juice from fermenting, a little lime is added, in order to neutralize the free acid, and heat sufficient to coagulate the albumen (a substance well known in white of egg, but common to all vegetable juices). After it has been allowed to cool, the clear juice is rapidly concentrated, either in open pans, or, what is better, in boilers from which the air has been partly exhausted; thus it is enabled to boil and evaporate at a lower temperature, accompanied by the formation of less uncrystallizable sugar. The crystals are sun-dried, packed into hogsheads, and brought to this country under the name of **Muscovado**, or raw sugar..

The process of **refining** consists in the removal of the colouring matter and other impurities. To accomplish this, nearly three parts of sugar are dissolved in

one part of lime-water, and mixed with a certain portion of animal charcoal and the serum of blood. [Serum is the pale, straw-coloured liquid which separates from blood when it is left to itself. It contains about eight per cent. of albumen.] When carefully heated, the albumen in the serum coagulates, or becomes solid, and forms a complete network, which rises to the surface, carrying with it all solid impurities. The liquid is now filtered through twilled cotton, and freed from colour by a second filtration through a bed of animal charcoal. It is then quickly evaporated in vacuum boilers, the advantage of which is proved by the fact that whereas the clear syrup boils in air at 110° C., it boils in absence of air (*in vacuo*) at 70° C. As soon as the sugar is capable of being drawn into threads, it is poured into a vessel heated by steam, and agitated with wooden oars till it granulates. Upon this agitation depends the whiteness of the sugar and the fineness of the grain. While the sugar is in this state, it is poured into conical earthen moulds (fig. 16), which are closed at

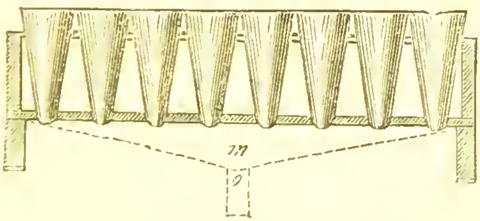


Fig. 16.

the narrow end by a small paper plug, previously soaked in water. When these moulds are sufficiently cold, the plugs are removed from the narrow end, and they are set with the broad ends upwards upon earthen pots to drain. As soon as the uncrystallizable

syrup has been run off, and altogether displaced by pure, colourless, crystallizable syrup, the "sugar-loaf" is baked in a heated chamber, and finished by turning in a lathe.

35. In making **sugar-candy**, the boiled sugar, instead of being agitated, is poured into vessels, across which threads are fastened. The pots are set in a stove, and in process of time the sugar is found deposited in crystals. **Barley-sugar** is sugar which has been first melted and then flavoured.

36. Pure sugar, or **sucrose**, is so well known as to require but little description. It is soluble in about one-third of its weight of water, and then forms a syrup. In strong alcohol it is altogether insoluble; hence a solution of it in water should be made, before any alcoholic liquor is introduced. Its sweetness can be comprehended when its solubility is taken into account, as nothing can be possessed of taste which is not soluble, any more than anything can be smelt that is not volatile. When a solution of sucrose is boiled or baked for some time, it loses much of its sweetness, because it becomes changed into a different kind of sugar—one that has not more than one-third of its sweetness. Hence we can understand the loss of sweetening power when sucrose is baked or boiled with acid fruits in pies and puddings.

37. **Sucrose** is one of the group of carbonaceous foods. It **consists** of **carbon** and the **elements of water**. [SUCROSE, $C_{12}H_{22}O_{11}$, differs but little from STARCH, $C_{12}H_{20}O_{10}$, in chemical composition.]

38. When heated, sugar melts, loses water, and becomes changed into "caramel," the French name for **burnt sugar**, which is so much used by cooks as a colouring matter, and for giving the rich brown tints to brandies and sherries, and the blackish colour to porter. [CARAMEL, $C_{12}H_{18}O_9$, differs from SUCROSE,

$C_{12}H_{22}O_{11}$, by the loss of only two atoms of WATER, H_2O.]

39. Although the general reader may pass over the exact chemical constitution of the sugars and the starches, if he be so minded, the more intelligent student will easily understand that starch and sucrose are equal, weight for weight, as an article of food. They are both insufficient for the support of life, true because they contain no nitrogen; but they are admirable as admixtures with other food, and fulfil a great purpose. Sugar is largely used in syrups and preserves, and is a great antiseptic or preventive of decay in meats, &c. In the form of **treacle**, which is nothing more than a syrup of uncrystallizable sugar, we have an admirable substitute for butter, and one that is bad more agreeable to most children. advice

40. **Grape-sugar** is another, but a less important variety of sugar. As will be understood from the name, it is the sugar of grapes, and is often seen to advantage upon dried raisins. It crystallizes with difficulty, and requires its own weight of water for solution; hence its sweetening power is only one-third that of sucrose. It is, however, much more soluble in alcohol. A sweet wine contains grape-sugar.

41. [GRAPE-SUGAR, or DEXTROSE, $C_6H_{12}O_6,H_2O$, differs but little from starch and sucrose in chemical composition. The conversion of starch into dextrose is easily accomplished by the aid of water, and large quantities are manufactured at the present day and sold as starch-sugar. A similar conversion of CELLULOSE, $C_{18}H_{30}O_{15}$ (par. 29), is also brought about by means of acids, and it is quite an easy matter to change a cotton handkerchief into more than its own weight of a sugar, which cannot be distinguished from grape-sugar or dextrose.]

42. Grapes, cherries, gooseberries, and figs contain, in addition to dextrose, or grape-sugar proper, **another kind of sugar**, which is called **Lævulose**. Honey contains, or rather consists of, both kinds. Chemically, the difference is so slight that no distinction can be made without understanding the composition, for the general reader will not realize that lævulose only differs from dextrose by containing one atom less of water. [LÆVULOSE, $C_6H_{12}O_6$; DEXTROSE, $C_6H_{12}O_6, H_2O$.] Many ripe fruits, of an acid character, such as pine-apples, strawberries, peaches, apricots, and citrons, contain sucrose, as well as lævulose. The latter sugar is not nearly so sweet as sucrose. The conversion of lævulose into dextrose is often witnessed in honey, which undergoes a change by long keeping into a mass of crystalline dextrose; if such honey be washed with alcohol, lævulose is removed in solution.

43. **Lactose** is the chemical name for "sugar of milk," the word being derived from lac, milk. It is the sweetening principle which, in cow's milk, amounts to between $4\frac{1}{2}$ to 5 per cent. After the milk has been curdled, and the curd separated, the whey holds the sugar in solution; it is evaporated to the consistency of syrup, small sticks of wood being introduced as centres round which the lactose crystallizes. Sugar of milk is seen in white semi-transparent masses, which are hard and gritty between the teeth, and require from five to six parts of cold water for solution. Of course, then, it does not possess anything like the sweetening power either of sucrose or dextrose. Nevertheless its value as an article of food is as great as that of starch or of sucrose, taken weight for weight. [LACTOSE, $C_{12}H_{24}O_{12}$, is insoluble in alcohol and ether. Its composition shows it to consist of carbon and the elements of water.]

44. The following amounts of sugar have been found in various products taken in 100 parts.

Muscovado sugar	96·0	Oatmeal	5·4
Treacle	79·0	Skim-milk	5·2
Figs	62·5	Milk	4·9
Cherries	18·1	Barley-meal	4·8
Peaches	16·5	Wheaten flour	4·2
Apricots and greengages	11·6	Wheaten bread	3·6
Pears, Buttermilk	6·4	Potatoes	3·2
		Turnips	3·1
Gooseberries	6·2	Peas	2·0
Carrots	6·1	Rice, Maize	0·4
Parsnips	5·8		

CHAPTER IV.

THE FATS, WITH THE INFLUENCE OF COOKING.

45. HOWEVER disinclined the reader may be to enter into any study of the chemical composition of food, he must become acquainted with the classification usually adopted, or he would fail to understand the nature of the various foods.

46. STARCHES, SUGARS, and FATS are bodies which consist of the three elements, **carbon, hydrogen,** and **oxygen.** The starches and sugars, as we have seen, consist of carbon and the elements of water; but the fats contain not nearly sufficient oxygen to burn their hydrogen, let alone their carbon, so that the oxygen and the hydrogen are not in the proportions to form water. To do this, there must be **two atoms** of **hydrogen** for **every atom** of **oxygen.**

47. Starches, sugars, and fats are called **respiratory**

or **carbonaceous** foods. They are respiratory, because they more readily keep up the animal heat of the body; carbonaceous, because carbon is the chief element, and to distinguish them from those which contain nitrogen. The respiratory foods assist in keeping up the supply of energy, and play their part, together with the **nitrogenous**, or **nitrogen-containing** materials, in forming a proper diet. For it may be safely said, neither is the one without the other: they are never quite separated the one from the other, except by the art of man.

48. **Lean meat** would afford the best illustration of **nitrogenous food**, and yet even the leanest sort contains some fat. While it is necessary to distinguish between carbonaceous and nitrogenous foods, we return to the subject of this chapter—**the fats.**

49. There are certain **general characters** attaching to the fats and oils. They are lighter than, and perfectly insoluble in water, but soluble in ether and in benzol. They possess different degrees of solidity. They have the property of staining paper, and rendering it semi-transparent.

50. Oils consist chiefly of **olein**, which is a colourless liquid, and remains so at temperatures above the freezing-point of water. Olive-oil, which is so much used in making salads, furnishes the best idea of olein. Now olein is also contained in the solid fats, and their hardness depends upon the greater or less amount of olein present in them; the more there is of olein, the less solid is the fat.

51. **Stearin** is the most abundant of the solid constituents of fats. In mutton suet we find three distinct fats — STEARIN, OLEIN, and PALMITIN; but stearin is the chief. When heated with about ten times its weight of ether, the whole dissolves; but the stearin crystallizes out, on cooling, in pearly scales.

52. **Palmitin**, which has been mentioned in the former paragraph, is contained abundantly in palm oil, from which it has received its name; it is also a chief constituent of cocoa-nut oil. It resembles stearin, but has a lower melting-point, and a somewhat different chemical composition. The principal solid constituent of butter is palmitin, just as olein is its chief liquid component.

53. **Lard** is the soft fat of the pig, in which the olein predominates over the stearin and palmitin.

54. Fats and oils may be heated to about 260° C. without undergoing any great change; but above that temperature they give off vapours of a most irritating character.

55. The fat best known in cooking, and the most esteemed, is **butter**. It is obtained from milk, chiefly from cows, which contains on an average 3 per cent. of it. As is well known, it is separated from the milk by churning. If the butter is for keeping, the more completely the butter-milk has been removed the better, and the addition of a little salt is a distinct improvement. The odour and flavour of the butter are not due to the olein and palmitin, of which it chiefly consists, but to the presence of small quantities of other fats, especially of **butyrin**. Unless it contain a little water—say 8 per cent.—butter is not so palatable as it might be; as water is cheap, it is more than probable that a larger quantity will be met with, even to the extent of 22 per cent. It is considered to be adulterated when mixed with more than 15 per cent., although it is obviously adulterated when it contains as much.

56. **Cream** contains about 30 per cent., **Cheshire cheese** 25 per cent., while **cheese** from skim-milk only contains about 7 per cent. of **butter fat**.

57. In **vegetables**, the amount of **fat** naturally

present signifies little or nothing. It becomes, however, a matter of great importance in animal food, and, indeed, in all kinds of food in the cooking of which the temperature is raised much above the boiling-point of water. Fats are not so easy of digestion when they have been strongly heated. By far the most wholesome form in which butter can be employed at table is as melted.

58. The following Table will give some idea of the amount of fat in different kinds of food.

	Per cent.		Per cent.
Butter	85 to 94·00	Herring	6·00
Bacon	67·00	Salmon	5·50
Pork (fat)	50·00	Ox-liver	4·00
Mutton (fat)	40·00	Milk	3·00
Beef (fat		Codfish	
Cheese, Cheddar	30·00	Rye	
Egg, yolk of		Peas	2·00
Tripe	16·00	Barley-meal	
Veal		Wheaten flour	
Eels	14·00	Rice	0·70
Egg, white and yolk	10·00	Parsnips	0·50
Maize	8·00	Soles	0·25
Mackerel	7·00		
Skim-cheese			

59. All the fats above-named are compounds of **fatty acids** with **glycerin.** Thus, **stearin** is a stearate of glycerin, **olein**, an oleate of glycerin, **palmitin**, a palmitate, and **butyrin** a butyrate of glycerin. When a mixture of stearin and water is forced under strong pressure through tubes heated nearly to redness, the fat is broken up into glycerin and stearic acid; the glycerin dissolves in the water, the fatty acid does not. Palmitin, the solid portion of palm-oil (which is obtained by heating the crushed fruit of a palm-tree), is thus broken up into the fatty acid, palmitic acid, and into glycerin. As palmitic acid possesses a higher melting-point than the palmitin from which it

is derived, it is more valued in the manufacture of candles.

[GLYCERIN is the sweet principle of fats and oils. As its name indicates, it is a sweet (*glykys*, sweet) syrup-like liquid, heavier than water, and capable of being mixed with it in any proportions. The chemical composition of fats may be judged by the following symbolical representations:—GLYCERIN, $C_3H_8O_3$, the basis of all these fats, is combined respectively with BUTYRIC ACID, $C_4H_8O_2$, PALMITIC ACID, $C_{16}H_{32}O_2$, STEARIC ACID, $C_{18}H_{36}O_2$, and with OLEIC ACID, $C_{18}H_{34}O_2$. But it must not be imagined that any of these fats consists simply of one molecule (as the smallest quantity imaginable of these substances would be written) of glycerin and one of the fatty acid! No; three atoms of the acid and one atom of glycerin, by the loss of three atoms of water, become respectively butyrin, palmitin, stearin, and olein. So we should write BUTYRIN, $C_3H_5O_3(C_4H_7O)_3$, or $C_{15}H\ \ O_6$; PALMITIN, $C_3H_5O_3(C_{16}H_{31}O)_3$, or $C_{51}H_{98}O_6$; STEARIN, $C_3H_5O_3.(C_{18}H_{35}O)_3$, or $C_{57}H_{110}O_6$; OLEIN, $C_3H_5O_3$ $(C_{18}H_{33}O)_3$, or $C_{57}H_{104}O_6$. It will be understood, at least, that in any of these compounds there is only oxygen enough to burn 12 atoms of hydrogen, as 6 atoms of oxygen are contained in 6 atoms of water, or HYDROGEN OXIDE, H_2O.]

60. **As** an article of **diet** the **fats** are of nearly **double** the **value** of **sugar** and **starch**. And, when perfectly dried, they are two and a half times as valuable. In cold weather, food rich in fat is generally acceptable, and, from its composition, the reason is clear. There is a large amount of hydrogen upon which the oxygen of the air can readily act; by its oxidation more heat is produced than by starch and sugar, weight for weight, as would be understood at once by using starch or sugar, as against fat

for fuel. With what a bright, cheery flame would a lump of bacon burn! What a dull kind of fuel, comparatively, would starch be. And yet, and for the same reasons, both would make a good fire.

CHAPTER V.

THE CHEMISTRY OF FERMENTED LIQUORS.

61. THE **foundation of all beverages is** necessarily **water.** Entering largely into the composition of the human body, it is the **only** natural solvent of foods and quencher of thirst. And yet, man, at an early period of his existence, learned to be dissatisfied with it, and turned his ingenuity to produce some more stimulating liquor. "Man," says Pliny, "is so skilful in flattering his vices, that he has even found means to render water poisonous and intoxicating."

62. The only substance capable of immediate fer**mentation**, that is, of producing by its change spirit of wine or alcohol, is **glucose** or **grape-sugar.** Starch can, by art, be rendered soluble, converted into dextrin and dextrose (par. 41), and lastly fermented. So that the starches and sugars may, one and all, under favourable circumstances, be fermented.

63. Very beautiful and instructive is the **process** of **fermentation.** The glucose receives nothing from the ferment: nothing, that is, of a material nature: nothing that it requires for the formation of alcohol, carbonic acid and water. Although glucose contains only water ready made, it has all the materials for making the carbonic acid and alcohol. Something,

however, it does receive. Like water altered in its physical condition by heat, or steel by magnetism, it receives what, in the language of philosophy, is called **force**.

Popularly, glucose may be said to be roused, in presence of a ferment, by a shake, which compels it to re-arrange its elements in some new form.

64. But, although glucose and a ferment are the only substances requisite for the process, the fermentation will go on only under certain conditions, and these conditions are two,—the **presence of water**, and a certain **fixed temperature**. It is not enough that the temperature be sufficiently high, but it is especially desirable, for the perfection of fermentation, that it be as nearly as possible the same throughout. In fermenting grape-juice, the most favourable temperature is found to be 21° C.

65. The **ferment** is **not** in the **juice** of the grape, nor does the juice ferment until it has been exposed to the **air**. The albumen (par. 109) in the juice furnishes the food to the fungus (or ferment), the germs or seeds of which are carried about in the air, and the fungus grows at the expense of its food. When once fermentation has commenced, the air is no longer necessary. Now the glucose rapidly changes ; heat is disengaged, and carbonic acid is set free. The escape of carbonic acid after a time is lessened, the sweetness of the juice disappears, and the liquid acquires a spirituous flavour from the presence of **alcohol**.

[In order to understand the formation of alcohol, a slight chemical explanation is needed. GLUCOSE, $C_6H_{12}O_6,H_2O$, contains WATER, H_2O, and the **elements** of alcohol and carbonic acid, twice told. ALCOHOL, C_2H_6O, and CARBONIC ACID, CO_2, will be found twice over in the chemical formula for glucose, after the removal of its water, which, by the way, it may be

made to lose when dried at the boiling-point of water—

$$
\begin{array}{ll}
\text{Two of alcohol} \left\{ \begin{array}{l} C_2H_6O \\ C_2H_6O \end{array} \right. & \\
\qquad\qquad\qquad\quad \left. \begin{array}{l} C \quad O_2 \\ C \quad O_2 \end{array} \right\} \text{Two of Carbonic Acid.} & \\
\qquad\qquad\qquad\quad \overline{C_6H_{12}O_6} &
\end{array}
$$

To speak more accurately, glucose breaks up, by the action of a ferment, into two molecules of alcohol, two molecules of carbonic acid, and one molecule of water. The molecule is the smallest quantity of an element, or of a compound in a **free state.**]

66. To describe all the subsequent processes would be beyond the scope of an elementary work such as this. Suffice it to say that, in ordinary cases, the wine is left in the cask till its fermentation is complete; but if it be desired to produce an **effervescing wine,** such as Champagne, and the sparkling wines of the Rhine and the Moselle, it is **bottled before** the **fermentation** is **completed.** The process is continued in the bottles, the carbonic acid being retained in the wine, where it must remain, under pressure, till the removal of the cork allows it to make its escape with effervescence. A good substitute for the expensive effervescing wines is an admixture of the light French wines with good mineral water.

67. When the quantity of the sugar in the grape predominates over that of the albumen (par. 109), the result is a more or less sweet wine. But when the albumen is in excess, the fermentation is more complete, and the wine has a dry character. It must not, however, be supposed that any wine is absolutely free from sugar, but some contain it in very minute quantities, and hence are the best adapted for certain classes

of invalids. Such wines are those of Bordeaux and Burgundy, Hock and Moselle, which are even stated by some writers to contain no sugar at all.

68. The blue **colouring** matter of the grape **resides** in the **skins**. The juices of both red and white grapes, under ordinary circumstances, make white wines, because the colouring matter of the skins is insoluble in water. It is, however, soluble in alcohol; if, therefore, red wine is to be made, the expressed juice is allowed to ferment in contact with the skins, until the formation of alcohol has extracted the colouring matter.

69. But something more than colouring is thus extracted. The time that the husks are in soak allows of the solution both of a **salt** of **iron**, and a peculiar kind of **tannin**. These, but especially the latter, give tonic properties to the wine,—a pint of Bordeaux containing a strong medicinal dose of iron. As time passes, a considerable portion of the tannin becomes insoluble, and is deposited, together with colouring matter, as "crust" in port and other coloured wines.

70. **Free acids** and **acid salts** are contained, more or less, in all wines, **tartaric acid, cream of tartar,** and **acetic acid** being the chief. These acids are, to most people, very digestible; they are present in smaller quantities in old wines, as alcohol causes the gradual separation of the tartaric acid in the form of cream of tartar, or acid tartrate of potash.

71. The **fragrance**, or "bouquet," of wines is due, mainly, to a peculiar ether, called **Pelargonic ether**, which forms gradually and very slowly in the wine.

72. The **colour** of dark sherry is artificial, being derived from **caramel**, or burnt sugar (par. 38).

73. The **quantity** of **alcohol** in wine may **vary** very much, both with the nature of the grape, the season, and the aspect of the vineyard. The majority of

French wines contain 10 per cent.; but Burgundy may contain, naturally, even 13·5 per cent. Most wines are fortified, that is, made stronger by means of alcohol: thus some kinds of "Port" contain 20 per cent. of absolute alcohol. One of the worst features of wines is the uncertainty as to the quantity of alcohol, and the amount of acidity which they possess. One of the greatest services which our wine-merchants could render would be to inform the public upon these points. And one of the greatest benefits which the people could confer upon themselves would be to admix strong wines with wholesome water.

[ALCOHOL, C_2H_6O, is a colourless, limpid liquid, of agreeable vinous odour, and somewhat pungent taste and smell. Its specific weight, as compared with water, is 0·793; it is therefore lighter than water. It is very inflammable, and burns with a bluish, sootless flame, into carbonic acid and water. Alcohol is a great solvent. Eau de Cologne and the various perfumed waters, the so-called essences, are solutions of essential oils in alcohol. Varnishes consist of resins dissolved in spirit of wine, and tinctures consist of bark, iodine, &c., dissolved in the same liquid. **Absolute alcohol**, as the strongest alcohol is called, can only be prepared by long treatment of strong spirit of wine with quicklime, and distillation. Except as a means of expressing the strength, no such thing as absolute alcohol can be considered as present in wine.]

74. **Proof-spirit** is, as nearly as possible, a mixture of one-half water with one-half alcohol (par. 89).

75. **Pure or absolute alcohol** is an undoubted poison. It possesses a strong attraction for water, which it abstracts from the tissues of the body with such avidity as to destroy their vitality; and, if taken into the stomach, it will rapidly cause fatal inflammation. But in wine the alcohol is strongly diluted, and its mani-

fest effects are produced on the nervous system; to this it is a stimulant, producing, in small quantities, a cheerful flow of spirits, in large, the too well-known phenomena of intoxication. The difference between wine "as making glad the heart of man," and wine "as a mocker," is almost too great to need enforcement.

76. Whether persons in robust health require the constant stimulus of wine or beer may be more than questioned; but one thing is certain, viz., that, with wine or beer, a more moderate allowance of food should suffice. In truth, however, few of our dwellers in towns are robust. The impurity of the air, and especially of the drinking-water, the habits of town life, the demands on the nervous system in the struggle for existence, and many other causes in operation in large towns, render the very moderate use of wine or good unadulterated beer beneficial.

77. In many cases of small or defective appetite, the benefit of wine cannot be questioned; in such cases it is a medicine, as all food should be. Wine and beer are clearly lawful only so far as they minister to health, energy, and virtue.

78. Cider and Perry are the fermented juices of apples and pears. In time, longer or shorter according to the temperature of the cellar, a part of the sugar is changed into alcohol, and an agreeable, though to some persons very unwholesome beverage, is obtained. Other home-made wines are prepared from the juice of gooseberries, currants, and elderberries. The acids in these wines are principally citric and malic. To make them even palatable they must be strongly fortified, and they thus often partake more of the character of spirits than of wines, and they are then, of course, injurious.

79. Beer is a kind of wine made from malt, and is one of the oldest of fermented liquors. The grain

employed is barley, which is "malted," in order to develop the peculiar ferment (**diastase**, an albumen-like substance), which has the property of converting starch into soluble dextrose (par. 41). The process consists in forcing the germination of the seed, and so bringing about by art what is accomplished on a grand scale in Nature in the germination of every seed and bud.

80. If a little malt be infused (soaked) in warm water, it will convert a very large amount of starch, first into dextrin (par. 28) and then into dextrose. It is sufficient to mix some warm gelatinous starch with a small quantity of malt-infusion, to insure its becoming, in a few minutes, thin like water, and, after a few hours, sweet like sugar. The liquor strained from the malt husks, called the "wort," is now boiled with hops, and rapidly cooled by running it into capacious wooden coolers; it is then mixed with yeast, and suffered to flow into the fermenting-vat. A great amount of froth is thrown up, arising from the escape of carbonic acid; the liquor loses much of its sweetness; from being turbid it becomes clear, and acquires a new taste and intoxicating properties from the formation of alcohol. The fermentation is stopped, when necessary, by separating the yeast and drawing off the beer into casks.

Fig 17.

81. The **yeast** above-mentioned consists of a multitude of small, oval, organized bodies (fig. 17), which do not exceed $\frac{1}{250}$ of an inch in diameter, and are seen to consist of nucleated cells. It is a fungus, to which the term *Torula cerevisiæ* has been applied, and is ob-

tained abundantly during fermentation in the manufacture of beer.

82. Various beers, though made from malt and hops, differ very widely in their properties. The amount of alcohol may be as low as $1\frac{1}{2}$ per cent. in small-beer, or even as high as $8\frac{1}{2}$ per cent. in Burton ale. Stout may contain 6 per cent., porter 5 per cent., or more, of alcohol reckoned as absolute (par. 73).

83. **Bottled** ales are more **acescent**, from the presence of much **free carbonic acid**, and are generally more alcoholic than draught ales.

84. Every kind of beer contains small quantities of **acids**: besides **carbonic acid**, **acetic** (par. 95) and **lactic** (par. 167) acids are present. When beer has become sour through the conversion of alcohol into vinegar, it may be corrected and fitted for use by the addition of sodium bicarbonate.

85. Dr. Carpenter, the great apostle of teetotalism, says: "There is another class of cases in which we believe that malt liquors constitute a better medicine than could be administered under any other form; those, namely, in which the stomach labours under a permanent deficiency of digestive powers. . . . There are many cases in which no form of medical treatment seems able to develop in the stomach that spontaneous power, which it has either completely lost, or which it never possessed, and in which the artificial excitement of an alcoholic stimulus affords the only means of procuring the digestion of the amount of food which the system really requires."

86. The chemistry of the **manufacture of ardent spirits** is so similar to that of brewing, that little requires to be said. The distiller, who prepares spirits from grain, uses a very large quantity of grain with the malt, the diastase (par. 79) of which is sufficient to convert the starch first into dextrin, and

then into dextrose. The "wash," as it is called in the language of the trade, is made to ferment as rapidly as possible by means of yeast added in large quantities, and is then distilled. **Whisky** is prepared from barley and oats. **Gin** and **Hollands** are distilled from barley, and flavoured with juniper-berries and other substances. **Arrack** is made from rice, a grain which contains a larger amount of starch than any other natural product. **Rum** is from the fermented juice of the sugar-cane. **Brandy** is obtained by the distillation of wine, and that made from white wines has the finest flavour. The wines from the countries bordering on the Mediterranean supply the largest proportion of brandies.

87. Vinous fermentation may be produced even in **milk**, and such a spirit is prepared by the Tartars. The milk-sugar changes into glucose, and this by a ferment into alcohol, carbonic acid, and water (par. 65).

88. With reference to the **quantity of alcohol** contained in spirits, it may be stated that few that are sold contain more than 49 per cent. of absolute alcohol. In mercy to the drinking public they generally contain much less; but they may contain more; and this uncertainty is an additional reason for the exercise of the greatest caution in their use. The alcohol from spirits is more readily absorbed than that in wine; hence is their stimulating power greater. Whisky is more wholesome (if the word can in any sense be allowed) than brandy, because its effects are more readily got rid of.

89. The term **proof-spirit**, already alluded to, is one applied by the Excise. Proof-spirit is defined by an Act of Parliament to be "such as shall, at the temperature of 10°·5 C., weigh exactly twelve-thirteenths of an equal measure of distilled water." It consists of alcohol 49·24, and of water 50·76 by weight [and

shows a dilute alcohol of specific gravity, 0·919 at 15°·5 C.]. The name takes its origin from the very rude "proof" formerly in use, in which gunpowder was moistened with the spirit of wine to be tried, and the alcohol ignited; if it fired the powder it was said to be over-proof; but if the spirit burnt off and left the powder damp, it was considered to be under proof. Every additional 0·5 or $\frac{1}{2}$ per cent. of absolute alcohol is said to be one degree above proof.

90. Apart from ill-health, the chief excuse for drinking spirits is due to the character of the water-supply. For wine much may be said. The late Professor Liebig is enthusiastic about its use. He says: "As a restorative, or means of refreshment, where the powers of life are exhausted, of giving animation and energy where man has to struggle with days of sorrow, as a means of correction and compensation when misproportion occurs in nutrition, and the organism is deranged in its operations, and as a means of protection against transient organic disturbances, wine is surpassed by no product of Nature or art."

91. This is said by Liebig of the wines of the Rhine, Moselle, and France,—wines which are not so alcoholic as some of the Ports and Sherries. Like all other gifts of God to His creatures, wine has been abused; nevertheless, it seems to admit of no doubt that, when used in moderation, it adds very greatly to the reasonable enjoyment of mankind. At any rate, as long as wines occupy such prominence among articles of consumption, as they undoubtedly do at the present day, a few pages devoted to their consideration can scarcely be thought to be out of place.*

* It would be of great advantage to the public if our wine-merchants would publish, with their prices, the alcoholic contents of their wines. And it would be well for the advance

CHAPTER VI.

THE VEGETABLE ACIDS.

92. FROM ancient times it has been well known that the juices of fruits, after becoming vinous (alcoholic) from fermentation, were subject to another change by which they were rendered sour. The acid formed has been long known by the name of **vinegar**, its production being common among the Egyptians before the time of Moses. Whilst the presence of oxygen or of air is absolutely necessary to the formation of vinegar, the vinous fermentation, when once commenced, is better carried on with exclusion of air.

93. All liquids capable of vinous fermentation may be made to produce vinegar; but in all such cases the sugar is first converted into alcohol, and alcohol, by oxidation, into **acetic acid**, the acid of pure vinegar.

94. [ALCOHOL, C_2H_6O, by oxidation becomes ACETIC ACID, $C_2H_4O_2$. By the loss of two atoms of HYDROGEN, H_2, which are oxidized, and become WATER, H_2O, and the addition of an atom of OXYGEN O, alcohol becomes acetic acid.]

95. And yet pure alcohol will no more become **acetic acid** by simple exposure to air than will a solution of pure sugar change into alcohol and carbonic acid. There must be some carrier of the oxygen of the air.

96. The **best vinegar** is made **from wine**. The wine is mixed with a little vinegar, and exposed to

of the good cause of temperance, if all wines containing more than 20 per cent. of proof spirit were admixed with water before drinking. The uncertainty as to the alcoholic contents of wines, and even beers, is a fruitful cause of intemperance, and a complete explanation of the evil, without any reference to adulteration.

the air in casks partly filled with the pressed husks of grapes. From time to time the liquid is drawn out from below, air supplies its place, the husks become warm by absorbing oxygen, which they give up to the alcohol, when the wine is again poured into the cask. This process is repeated until the vinegar is made; its strength may be increased by the addition of more or less brandy to the wine. Free access of air, a temperature not below 24° C., and exposure of a large surface of liquid, are the chief conditions of success.

97. Acetic acid is a clear, colourless liquid, which crystallizes below 15° C. in colourless scales. In this condition it blisters the skin; but ordinary vinegar only contains about 5 per cent. of acetic acid, and is then possessed of a pleasant, sour taste. In small quantities good vinegar promotes digestion, serves to flavour food, and to excite the nerves of taste.

98. Acetic acid is contained in wines, but **tartaric acid** is the chief acid; and then, not as tartaric acid, but as a salt of potassium, the so-called "cream of tartar." This salt has an acid taste, and is but little soluble in water. In alcohol it is even less soluble, so that it is found collected as a crust in the wine-casks. From cream of tartar, all the tartaric acid of commerce is produced. As this cream of tartar is very digestible, a wholesome drink for summer use may be prepared by dissolving a drachm in one pint of water, sweetening according to taste, and flavouring with lemon. (If the drinking-water should be of doubtful character, it is better to use boiled water for the manufacture of this drink.)

[TARTARIC ACID, $C_4H_6O_6$, is also the sour principle of tamarinds and pine-apples. When pure, it forms clear, colourless crystals, very soluble in water, and possessed of a sour taste. It is employed in making

effervescing draughts, as it drives out carbonic acid from sodium carbonate, and forms sodium tartrate. POTASSIUM HYDROGEN TARTRATE, $C_4H_5KO_6$, is cream of tartar.]

99. Currants, both red and white, contain two acids, **citric** and **malic**. The same two acids are also contained in strawberries, gooseberries, cherries, and raspberries, in the cranberry, and the whortleberry; but the chief source of citric acid is the lemon and the citron, although it is also contained in the orange. It is even more digestible than tartaric acid, and serves equally in the making of effervescing draughts.

[CITRIC ACID, $C_6H_8O_7,H_2O$, as it is sold in the form of large transparent crystals, closely resembles tartaric acid. It has an agreeable acid taste, and is very soluble in water.]

100. MALIC ACID derives its name from **Prunus malus**, the apple, in which fruit the acid is found. It is also contained in garden rhubarb, and largely in the berries of the mountain ash. The dried leaves of tobacco are rich in a salt of malic acid. It is only made upon a very small scale, but its sour taste is well known and liked in a sour apple.

[MALIC ACID, $C_4H_6O_5$, differs but little from tartaric acid, and is easily converted into it by chemical means.]

101. **Oxalic acid** accompanies malic acid in the garden rhubarb, in sorrel and in the shamrock, known by the botanical name **Oxalis acetosella**. It is possessed of a pleasant, sour taste, but is nevertheless poisonous when taken in quantity. Salts of oxalic acid are called oxalates; that of potassium is sold in the shops under the name of "salts of lemon."

[OXALIC ACID, $C_2H_2O_4$, $2H_2O$, resembles Epsom salts in appearance. The best antidote to poisoning by this acid consists in a dose of magnesia or of chalk.]

102. Scattered through the vegetable kingdom, in the bark and leaves of many trees and shrubs, is an astringent principle, which goes by the name of tannin, or tannic acid. It is obtained in a state of purity from the gall-nut, and is possessed of a very astringent taste, well understood by the manner in which it draws the mouth together. Coffee and tea contain also a kind of tannin, but the properties are different. Thus, the tannin of tea will give a blue-black colour with a salt of iron, but that of coffee will not. A cup of strong, rough congo owes its astringency to tannin.

[TANNIN, $C_{27}H_{22}O_{17}$, has already been mentioned as an important constituent of red wines (par. 69). It presents the appearance of a yellow powder, very soluble in water. Black ink is tannate of iron, a stain from which upon linen is best extracted by means of oxalic acid.]

The most remarkable property of tannin is its power of combining with gelatin, and forming leather. A solution of tannin will immediately precipitate as a solid body the gelatin contained in soups, and will have an effect of hardening meat, and rendering it less digestible.

103. Vegetable acids are exceedingly numerous; but the only ones of any importance in fruits and vegetables, leaves and seeds, are those just mentioned. In moderation, all but oxalic acid are peculiarly wholesome, and the quantity of the latter in the cooked rhubarb of a pie or pudding is too small to affect the health. The introduction of the orange has had much to do with the better health of our people; indeed, it would be well if larger quantities were consumed, and an orange, while in season, took the place of beer at dinner.

CHAPTER VII.

EGGS, ALBUMEN, AND MILK.

104. It is a very common thing to **classify** foods, and to divide them into **carbonaceous** (respiratory) and **nitrogenous** (plastic).

Carbonaceous foods would be such as have been already considered; namely, compounds of carbon, hydrogen, and oxygen. In Nature, these are always more or less associated with nitrogenous matters; it is by art, more or less, that they are separated. It is true that in milk we have water, butter, and sugar, but we have also **casein** (nitrogenous). In bread we have water and starch, but also **glutin** and **albumen.** Oatmeal contains starch, water, and fatty matters, in addition to **fibrin.** Lentils abound in starch, but also in **legumin.** Vegetables, such as cabbages, greens, turnips, and carrots, are chiefly valuable on account of their juiciness, and do not yield more than 2 per cent. of nitrogenous materials.

105. **Nitrogen** is a component of the air. That the atmosphere does not consist wholly of one kind of matter is readily shown by the following experiment: a float made of cork, into which is fitted a tiny porcelain basin, containing a piece of phosphorus about the size of a pea, is placed in a soup-plate full of water, and over it is inverted a deflagrating jar, open at the bottom and carefully stoppered. On removing the stopper, the water will stand on a level inside and outside the jar. The phosphorus is then inflamed by means of a heated wire introduced through the neck of the bottle, and the stopper immediately replaced. The phosphorus burns brilliantly for a time, producing white vapours of phosphoric acid, soon dissolving in the water, which then rises in the jar (fig. 18), till

it fills one-fifth of the space previously occupied by the air. By the combustion, therefore, of the phosphorus, something has been removed from the air in the jar equal to one-fifth of its whole bulk.

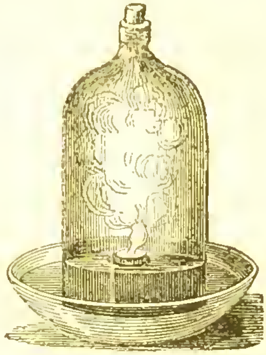


Fig. 18.

The matter so removed is **oxygen**; the gas left behind is **nitrogen**. More accurately, the atmosphere when dry consists of 79 per cent. by measure of nitrogen, and of 21 per cent. by measure of oxygen. Like oxygen, nitrogen is a colourless, tasteless, and inodorous gas; but it does not support either respiration or combustion. Its presence in such large proportion in the atmosphere is a proof that it is not injurious to respiration, while it serves to check the activity of breathing as well as of combustion. From the difficulty with which it enters into combination, nitrogen is admirably adapted for this purpose; indeed, there is no other gas which could be made to take its place.

106. NITROGEN is always in combination with the elements of the carbonaceous group. In its separate form, mingled with the air, it cannot take the place of food. It must be in chemical combination with CARBON, HYDROGEN, and OXYGEN, if it is to do us any service. The difference between mixture and combination is thus well seen. In a **mixture**, bodies retain their individual characters; in a **combination**, these are lost. All kinds of food which contain nitrogen are solids; nitrogen itself is a gas.

107. The **best proof** of the presence of **nitrogen** in a body is furnished when, in heating it with quicklime, it gives off **ammonia**. Now ammonia is a com-

pound of nitrogen and hydrogen, and is well known as hartshorn. It is one of the most valuable of manures to plants, and supplies them with nitrogen; but it cannot serve as food to man or beast. Decay and putrefaction minister to the life and growth of vegetation; indeed, the very value of manures depends upon the amount of ammonia which they contain or afford.

108. Amongst nitrogenous foods, one of the most useful and handy is an **egg**. Taking it as weighing $1\frac{3}{4}$ oz., it would yield about 2 per cent. of nitrogen, or nearly 18 grains. **Now, as about 200 grains of nitrogen are required daily by a grown-up person** doing but little active work, it would follow that, if he lived upon eggs (a most absurd supposition), he would require 11 per day.

If an egg be carefully analyzed, it would be found to consist of 70 per cent. of water and 30 per cent. of solid matters. The **solids** would be divisible into **white of egg** and **yolk**; the latter consists of similar material to the white, but contains the tasty principle —an **oil rich** in **phosphoric acid**, and admirable as a restorative. In the yolk, the **oil** amounts to about **one-third** of the weight of the total solids, and is to be classed among the **respiratory kinds** of foods.

109. **Albumen** is the most noteworthy principle of the egg, and it is a substance of such importance as to be worthy of a more extended description. The best understood character of albumen is its property of becoming solid and insoluble in water on the application of heat. This coagulation or curdling begins at 60° C. If the quantity is large the white sets, as in an egg which has been hard-boiled; if the quantity be small, the liquid containing albumen simply becomes cloudy. In carrots and turnips and cabbages, wherein the quantity is very small, the water in which they are boiled simply becomes unclear or turbid; in the

juice of meat, where there is much albumen (par. 116), distinct coagulation takes place; but even in this there is but little compared with white of egg.

110. If the heat of **boiling water** (100° C.) be allowed to penetrate, both the **white** and **yolk** become **solid**; in five minutes' time from the placing in boiling water, an egg becomes **hard** throughout. Now, the setting of the yolk depends upon a variety of albumen, known as **vitellin**.

111. The **tastelessness** of the **white** without the yolk is a well-known fact, and alluded to in the Book of Job: "Is there any taste in the white of an egg?" But the value of an egg as an article of food may be adjudged by the fact that, by the help alone of air and warmth, the flesh, bones, membranes, and feathers of the fowl are produced.

112. The presence of **sulphur** in albumen ought also to be remembered, as it makes itself seen in the blackening of a silver spoon when left in an egg. And the well-known ill-savour of a putrid egg is equally due to the sulphur, which, with hydrogen, produces hydrogen-sulphide, or rotten-egg gas. On account of the action of sulphur upon silver, it is usual to gild the bowls of silver egg-spoons. **Omitting** the **soda** which is contained in albumen, and which occasions the bluing of a piece of red litmus-paper when inserted into the white of egg, and taking the **phosphorus** into account, the following will give the composition of perfectly dry albumen in 100 parts:—

Carbon	53·5
Hydrogen	7·0
Nitrogen	15·5
Oxygen	22·0
Sulphur	1·6
Phosphorus	0·4
	100·0

[ALBUMEN varies greatly according to the source from whence it is derived. OVALBUMEN, as that from the ovum, or egg, is called, is an albuminate of sodium, and may be represented by the formula $C_{72}H_{111}Na N_{18}SO_{22},H_2O$. It occasions a precipitate in solutions of metallic salts, and therefore raw eggs, beaten up, are a most valuable household remedy against poisoning by salts of lead, mercury, and copper. Strong alcohol also coagulates and hardens it, as does also creasote. Albumen is coagulated by ether, and does not precipitate salts of lead and copper, and is thus mainly distinguished from ovalbumen.]

113. Albumen constitutes about 7 per cent. of the blood, and is an essential of the brain, liver, &c. It is not found in the refuse of the body, except in disease.

114. As an **article** of **food**, what cannot be said **in praise** of an **egg**? With milk it gives custard-pudding; it may be eaten raw, soft-boiled, hard-boiled, poached, in the form of omelets, in soups, in many ways—and yet others would remain to be told. It is impossible to exaggerate its value. Eaten with bread and butter, or with toast, an egg may be made to go as far as five eggs eaten by themselves, and the appetite, on account of the variety thus introduced, would not tire. The starch of bread and toast would increase the quantity of respiratory food contained in the yolk, whilst the albumen of the white and yolk would be supplemented by the nearly equally valuable gluten of the bread and toast. The same may be said of eggs and bacon. Eggs are also useful as vehicles for salt, which greatly promotes digestion generally, as well as the digestion of the albumen itself.

115. It has been already stated that **albumen** is contained in blood; it is therefore a **constituent** of the **juice** of **meats**. The quantity of albumen in certain animal foods has been found as follows:—

	Albumen per cent.		Albumen per cent.
In beef	2·02	In pigeon	4·05
In chicken	3·00	In sweetbread	14·00
In veal	3·02	In ox-liver	20·19

These quantities of albumen are exclusive of fibrin (par. 142).

116. If an **extract** be made of **finely-minced meat** with **water**, a reddish-coloured fluid is obtained, having the taste peculiar to the blood of the different classes of animals. When heated to between 65° and 70° C. (depending upon strength; as the more diluted with water the higher is the temperature required), the albumen which it contains coagulates, and carries with it the colouring matter. The clear **liquid**, or broth, will be found distinctly **acid.** But the great point to be remembered is, that if the juices of meat be extracted with cold water, all the **albumen** is **transferred** to the **water**. Now, since meat, taken as food, is again to become flesh in the body, it should, as far as possible, contain all the original constituents of the raw meat. So, when the meat is to be eaten, the albumen should be retained in it; for not only does it preserve the fibrin from becoming hard, but it gives to it softness and delicacy. The best method of **boiling meat intended** for **food**, is to introduce it at once into boiling water. If the boiling be kept up for five minutes, and then so much cold water added as to reduce the temperature to 75° C., and the whole kept slowly simmering until it is cooked, all the conditions are united which give to the flesh the quality best adapted for its use. When it is introduced into the boiling water, the **albumen** immediately **coagulates** from the **surface inwards**, and in this state forms a **crust** which no longer permits the outer water to penetrate into the meat. But the temperature is

gradually transmitted inwards, and there accomplishes certain changes.

117. **Tripe** is rich in nitrogenous material, and contains a considerable proportion of albumen. When properly cooked, it is very digestible, and, from its cheapness, offers to the poor a valuable kind of food.

118. And now as to **milk.** In addition to carbonaceous material, such as BUTTER and LACTOSE (sugar of milk), milk contains about 4 per cent. of a nitrogenous substance called **casein.** Every one knows that, when milk becomes sour, it coagulates. This coagulation is owing to the separation of the casein with the butter, and is not the effect of heat, as is the case with albumen. Milk when simply boiled is covered with a skin, or scum, of oxydized casein. A minute quantity of vinegar, or acetic acid, separates the **curd** or casein, and this carries the butter down with it. Advantage is taken of this in the manufacture of cheese, which consists principally of casein and butter. Coagulation is accomplished by means of "rennet," the inner membrane of the fourth stomach of the calf after it has been salted and dried, and a clear, straw-coloured liquid, the **whey,** is left. The cause of the coagulation is not known, but the result is a very valuable article of food—**cheese.**

119. New cheese has but little flavour, as is perceived in fresh **cream-cheese.** As the latter is often made from skim-milk, from which the cream has been abstracted, the cheese contains but little butter, and consists mainly of casein. Even new cheese has but little flavour, and it is only with the lapse of time that certain acids are developed, possessed of smell and taste, which give pungency and flavour.

120. The **composition** of **cows' milk** is as follows. It has a specific gravity of 1·030 to 1·034. Cream amounts to about 10 per cent.

Water	87·5
Fat	3·5
Casein and insoluble salts	4·0
Sugar and soluble salts	5·0
	100·0

121. If human milk is to be imitated, good cows' milk requires to be diluted by one-third of lukewarm water, and sweetened by means of one quarter of an ounce of sugar to each pint of milk and water.

122. Half a pint of new milk would supply as much nitrogenous material as a good-sized egg; the value of milk may therefore be easily understood.

123. The reader will observe a considerable difference between milk and cheese. The latter may contain in different specimens :—

	Cheddar.	Cheshire.	Skim.
Water	36·0	30·0	44·0
Casein	28·4	39·5	44·8
Butter	31·1	26·0	6·3
Salt	4·5	4·5	4·9
	100·0	100·0	100·0

The most valuable of the three cheeses would be the Cheddar, as the Cheshire and the Skim-cheese are really too rich in nitrogenous material, without very large admixture with carbonaceous food. The Cheshire is obviously greatly superior to the Skim-cheese, as the butter is four times as largely present.

124. A small piece of cheese, as large as a hazel-nut, acts as a digester of food; but after a hearty meal cheese is too tempting to be placed upon the dinner-table. To give variety to food in a poor man's house, macaroni and cheese are most admirable, and would supply a supper at an inexpensive rate. Macaroni may be looked upon as high-class bread, and should be introduced into every household at

least once a week. **One pound** of **Cheddar cheese** would afford about 300 **grains** of **nitrogen** ; it will therefore be easily understood why cheese is so highly regarded by the hard-working labouring man.

125. The most digestible form of cheese is cream-cheese, when kept sufficiently long to possess a distinct flavour, but before it has begun to decompose.

CASEIN contains **less** of **sulphur** than does albumen, and **no phosphorus** ; otherwise their composition differs but little. It may be prepared by coagulating skim-milk by means of dilute sulphuric acid. The curd, after well washing with water, may be dissolved in sodium carbonate, and allowed to stand for twenty-four hours to give time to the butter to collect on the surface ; this is then skimmed off, and the casein again precipitated by sulphuric acid. After washing with water, the casein should be purified by digestion with ether, in order to remove remaining traces of butter. (For Sulphur and Phosphorus see Chapter X.)

126. The solubility of casein in water is not destroyed by alcohol ; hence a moderate quantity of beer is a good accompaniment of a meal of bread and cheese. Water is, however, a better drink.

CHAPTER VIII.

BREAD AND MEATS.

AMONG the more substantial articles of food, **bread** and **meat** occupy a very high place.

127. The valuable **grain** called **wheat** is the produce of several kinds of the genus TRITICUM, winter-wheat and spring-wheat being the most common. Like rye, oats, barley, and rice, it belongs to the

natural family of the **grasses** (*Gramineæ*), a family which includes some of the most useful, and the longest-cultivated plants in Europe. As a great poet says: "A cornfield represents God's battalions against hunger."

128. Wheat is composed principally of a floury portion, which is enclosed by an integument, or shell, amounting to about 14 per cent. of the whole grain. The **flour** consists of **starch** (par. 26) and **glutin**, with small quantities of gum, albumen, and certain salts.

129. As starch is the main carbonaceous, so is **glutin** the main **nitrogenous constituent** of wheat or **flour.** Glutin is to bread what casein is to milk; in their absence, neither bread nor milk could be considered nutritious in respect to nitrogen. Glutin is readily obtained, by kneading a mass of dough in a muslin bag under a running tap, by which means the starch is carried off, leaving a greyish, glutinous, highly-elastic substance; it resembles birdlime in appearance, and is perfectly insoluble in water. The glutin from wheaten flour is singularly tenacious, and renders it peculiarly well adapted for making bread.

130. Glutin is composed of three distinct nitrogenous substances, one of which, **fibrin,** corresponds to the fibrin of meat (par. 142), and is seen in greatest perfection in oatmeal. A variety of **vegetable casein** is also present together with the glutin, which gives to the whole its adhesive or sticky properties. Vegetable casein, as well as animal casein, contains no phosphorus.

131. In **making bread,** the flour is mixed with half its weight of water, and thoroughly kneaded into dough, with the addition of salt (**sodium chloride**), to make it tasty and wholesome, and of yeast (par. 81) to make it ferment. The water, yeast, and flour being

mixed, the mass is left to rest for some hours at a temperature of about 21° C. Fermentation commences almost immediately; the **dextrose**, which is **produced** from the **starch** by the action of the **ferment**, is quickly **changed** into **alcohol** and **carbonic acid**. The carbonic acid thus set free at all parts of the dough, causes it to rise, and to increase greatly in bulk. The dough is then cut into loaves, and baked in an oven at a temperature of 230° C. to 260° C.; the heat causes a still further expansion of gas in the dough, which also loses a portion of its water, and thus prevents any great rise of temperature in the crumb. According to experiments made by the author, the crumb is rarely heated to 94° C., but the crust is greatly altered. Much of the **starch** becomes **changed** into **dextrin**, and is soluble and more digestible, as it partakes of the character of biscuits. The lightest part of the loaf is that which has not been compressed by the oven-plate. By the act of baking, the starch granules lose the property of forming a gelatinous paste with water, and form, together with the glutin, distinct but irregular cells, which are among the best characteristics of a well-baked loaf. The oven should have been sufficiently heated to harden the sides of these cells, so as to retain their form after the loaves have been removed.

132. The **amount** of **water**, in the crust and crumb together, is equal to 38 per cent. of its weight. The **difference** between **fresh** and **stale** bread is not owing to the quantity of water (as the loss on the part of the stale loaf is not more than 1 per cent.), but rather to the **condition** of the **starch**. Stale bread may be readily changed into the condition of fresh by enclosing it in a tin case, and replacing it in the oven for a short time.

133. The presence of **dextrin** (par. 28) in the **crust**

of bread is easily proved. If a loaf be wetted with a moist sponge, and returned to the oven, it will soon possess a shining coat, as though glazed with gum ; the water has dissolved a portion of the dextrin. In the making of toast, much more of the starch is thus changed, and this is no doubt one of the reasons of its greater digestibility.

134. A thin slice of well-made toast, a little burnt upon its surface, has been already suggested as a cheap means of filtering water, and of preparing toast-and-water (par. 14). But it must be made with boiling water, or, at least, from water which has been boiled.

135. Leaven is sometimes employed instead of yeast. It is merely dough kept in a warm place until a portion of its gluten becomes changed by atmospheric air, through the instrumentality of germs, into a ferment. "A little leaven leaveneth the whole lump," and brings about the same changes as yeast. As it frequently sets up an acid fermentation, and makes the bread sour, it is not much used in England.

136. Pure white bread is not so nutritious as that made from seconds-flour. This, to well-fed persons, is of no importance, as they make up with meat and eggs what the bread may lack in glutin. But, to the poor, it is a matter of interest. Indeed the entire removal of the bran, except to persons in delicate health, is decidedly objectionable ; the latter is rich in fat, as well as in phosphates, and, if only finely ground, renders bread more tasty.

137. In bread made by the ordinary process of fermentation, a certain loss is occasioned by the conversion of some of the starch into dextrose, and then into alcohol and carbonic acid. To obviate this waste, several plans have been suggested. By Dr. DAUGLISH'S

process, **carbonic acid gas** is pumped into the dough, and is made to produce the same effect mechanically, as is done by the loss of a certain weight of starch. Or the carbonic acid is obtained from sodium bicarbonate, by means of tartaric, or some other acid. In the baking of cakes, ammonium carbonate and sodium bicarbonate are similarly employed, but not quite with such good results.

138. **One pound of bread** will supply between 90 and 100 grains of **Nitrogen**, and about **twenty** times as much **Carbon.** With bread at 2d. per lb., it will be seen how cheaply our needs in respect to nutrition may be supplied. It may be calculated that $2\frac{1}{2}$ lb. of bread would supply our daily wants, at least as regards the most costly element, nitrogen, and we can obtain very considerable variety in the use of flour. With dripping, butter, lard, or suet, we can make pies and pudding-crusts; those made with suet are the most digestible.

139. **Macaroni** is a very admirable variety of a rich form of bread, and, with cheese, is much to be recommended. It is a manufacture of wheat which for a long time was peculiar to Italy. Strictly speaking, the name only applies to wheaten paste in the form of pipes, varying in diameter from an ordinary quill up to those now made of the diameter of an inch; but there is no real difference between it and the fine threadlike **Vermicelli.** Only certain kinds of wheat are applicable to this manufacture, and these are the hard sorts which contain a large per-centage of glutin. The wheat is first ground into a sort of meal, from which the bran is removed—in that state it is called **Semola**; during the grinding it is necessary to employ both heat and moisture. The semola is worked up with water into a dough, and, for macaroni and vermicelli, it is forced through gauges, as in wire- and

pipe-drawing. If the taste of macaroni with cheese be objected to, there are many kinds of puddings in which it can be advantageously employed.

140. Whilst on the subject of flour, there is no meal so much to be recommended for cheapness and excellence as **oatmeal. One pound of oatmeal** contains about 140 grains of **nitrogen.** When cooked with water, and eaten as porridge with milk, it affords variety in diet, and is very wholesome withal. Or it can be eaten with salt, or with sugar and butter, or with treacle, and should be a welcome addition to the small variety in food in which most people indulge.

141. If to bread we add **meats,** we shall have considered the chief portion of the subject of food.

142. The components of lean meat, so far at least as regards its nitrogenized constituents, are very similar to those of vegetables. **Muscular fibre, muscular tissue** or **Syntonin,** is composed chiefly of **fibrin.** A thin slice of lean beef, washed in cold water until perfectly white, and then, when dry, with ether, until all the fat has been removed, affords a good example of insoluble **animal fibrin**; whilst that portion of the glutin of wheaten flour which is insoluble in hot alcohol and in ether, represents the best idea of **vegetable fibrin.**

143. The **fibrin** in **blood** amounts to 0·25 per cent. Because, in muscle, it arranges itself in bundles of fibres, it is called fibrin.

There are two varieties of FIBRIN, one soluble, the other insoluble. The soluble variety is met with in the blood, and is readily obtained by beating freshly-drawn blood with a bundle of twigs; in the moment of coagulation, the fibrin attaches itself in white, elastic fibres, and may be afterwards washed clean by kneading in water.

[In regard to its chemical composition, FIBRIN differs but little from coagulated albumen, as will be seen at once by comparison of their constituents.

	Fibrin.		Albumen.
Carbon	52·7	...	53.5
Hydrogen	6·9	...	7·0
Nitrogen	15·4	...	15·5
Oxygen	23·5	...	22·0
Sulphur	1·2	...	1·6
Phosphorus	0·3	...	0·4
	100·0		100·0

Blood fibrin would seem to be **oxidized albumen** Blood fibrin decomposes hydrogen peroxide; albumen does not. Both fibrin and albumen are soluble in dilute solutions of potash, but, on neutralizing the solution with acetic acid, fibrin is precipitated, and not albumen. Solutions of fibrin and of albumen in acetic acid are precipitated on addition of yellow prussiate of potash.]

144. That which we call **butcher's meat**, is the muscular substance, with more or less of bone and fat. It may be said to consist of :—

Juice of meat	71
Muscular tissue	16
Bones	10
Fat and cellular tissue	3
	100

145. With an **increase of fat**, the **quantity of water present in meat decreases**; well-fed and fattened meat contains for equal weights about 40 per cent. more of dry animal matter than non-fattened meat. The following analyses by BREUNLIN exhibit the difference between the meat of fat and non-fatted bullocks :—

	Fattened.		Non-fattened.
Juice	39·48	...	61·12
Muscular tissue	36·65	...	30·81
Fat	23·87	...	8·07
	100·00		100·00

146. **Albumen** and **fibrin** are, then, always met with together in various kinds of meat. In veal, chicken, and beef, we have about 20 per cent. of fibrin to from 2 to 3 per cent. of albumen; whilst in sweetbread we have about 8 per cent. of fibrin to 14 per cent. of albumen. As has been already remarked, since meat, taken as food, is again to become flesh in the body, it should as far as possible contain all the original constituents of the meat. According to the usual plan of boiling meat, the albumen is coagulated, and thrown away in the water, and the fibrin much hardened in consequence. Now **meat** intended for boiling should be **immersed** in **boiling** water, so that the outer part has its albumen coagulated, and thus the juices prevented from passing into the water. As soon as this is accomplished, which takes place in the first ten minutes, the water should be somewhat cooled down (from 100° C. to 80° C.) by the addition of a small quantity of cold water, and the cooking completed by gentle simmering. The water should only be just on the boil, for which purpose a very small fire is necessary. As regards the water in which the meat has been cooked, it should be so reduced in bulk by evaporation, as to be just sufficient to serve as gravy, or to be used as stock for soup.

147. So then, if the **meat** is to be **eaten**, the **juices** are to be **kept** in the **meat**; but, if **beef-tea** is wanted, the chief **goodness** of the **meat** should be **in** the **tea**. According to the late Professor LIEBIG, the great master on the subject of food, finely-minced meat should be extracted with its own weight of cold or

lukewarm water: digested for an hour, all the albumen and the other soluble and tasty ingredients will be removed into the tea. On straining through a sieve and slight washing with water, the beef-tea may be heated, flavoured according to taste, and served with the albumen,—coagulated indeed, but still nutritious as in a boiled egg.

CHAPTER IX.

GELATIN AND BONES, WITH SOMETHING ABOUT THE JUICES OF MEATS AND LIEBIG'S BEEF-TEA.

148. If the value of a nitrogenized substance could be judged by the amount of **nitrogen** which it contains, then indeed would **gelatin** stand very high. Isinglass is an example of the purest kind of gelatin, and glue of an inferior sort.

149. **Isinglass** is prepared from the inner membrane of the floating bladder of the sturgeon. **Glue** is made from bones. Not that the bones contain gelatin, but it is the result of the long-continued action of boiling water upon such bodies as skin, the organic (destructible) matter of bones, &c.

150. Now the composition of **bone** is somewhat as follows:—

Animal matter yielding gelatin	30·58
Calcium phosphate	57·67
Calcium carbonate	7·00
Magnesium phosphate	2·10
Calcium fluoride	2·65
	100·00

151. When boiled for several hours even, bones give but a small proportion of gelatin; but, if placed with water in a Papin's digester and heated to about 150° C., gelatin is very largely, if not completely, dissolved. The more the bones are broken, the thicker is the jelly which is obtained, and also at an expense of less firing.

152. Gelatin is readily soluble in warm water; even one per cent. will cause water to **gelatinize** on cooling. Its solution is tasteless, and without odour. Alcohol **precipitates** it, and so also, but more completely, does **tannin**; indeed leather is a compound of tannin with gelatin. From albumen and fibrin gelatin may be readily distinguished, in that it is not precipitated from its solution in acetic acid by yellow prussiate of potash. [See par. 143, enclosed in brackets.]

153. **Gelatin** contains **more nitrogen** and less carbon than either albumen, fibrin, or casein; like the latter it contains no phosphorus, but it contains more sulphur than casein. The composition of gelatin, it may be as well to contrast with casein, albumen, and fibrin.

	Gelatin.	Casein.	Albumen.	Fibrin.
Carbon	50·4	53·83	53·50	52·70
Hydrogen	6·5	7·15	7·00	6·90
Nitrogen	16·9	15·65	15·50	15·40
Oxygen	25·6	22·52	22·00	23·50
Sulphur	0·6	0·85	1·60	1·20
Phosphorus	none	none	0·40	0·30
	100·0	100·00	100·00	100·00

Clearly then, chemical analysis can tell us only the constituents of food; experience and judgment are required to make use of such analysis. For, if one thing be more certain than another, it is, that equal

weights of properly cooked gelatin and albumen are not equally nutritious.

154. To a person in delicate health, **gelatin** is rather a **vehicle** for food, than food. Jellies may be sweetened with sugar, made tasty with wine, and give, as it were, some solidity to water; they may convey the sensation of food. Gelatin is at its best when it contains the juices of meat.

155. Nevertheless, as a **solvent of phosphates** (the earthy material of bones), gelatin is of great value, especially to children the nutrition of whose bones is defective. But it can only partially replace albumen and fibrin. It is as an aid to nutrition, as giving variety to our food, as affording bulk and giving the stomach something to do, that gelatin is most valuable.

156. To persons in health, and in houses where price is of great importance, the bones from joints, &c., should be broken up and boiled in water, in a Papin's digester for a couple of hours, and the gelatin-soup thus obtained should be rendered tasty by fragments of well-roasted fresh meat, and the addition of various vegetables, such as celery, carrots, onions, &c.

157. **Taste** being the best test of good **cookery**, it is obviously of the highest importance in cooking to retain, as far as possible, the sapid (tasty) principles. The practice of boiling meat with large quantities of water, which is thrown away, and with it the whole, or nearly the whole, of the soluble matters, is clearly objectionable. With the albumen and gelatin which would thus be lost, we have already become familiar; but these are not all.

158. There is also in the water a highly-nitrogenized substance, by name **kreatin**, so called from the Greek **kreas**, flesh, because contained in meats. One pound of fresh beef or mutton yields about 5 grains of kreatin; the same weight of fowl about half as much again. It is

obtained most cheaply from codfish. It presents a brilliantly crystalline appearance, and its solution in water has a weak, bitterish taste. What part it plays we cannot tell; but as we find kreatin in the juice of fish, flesh, and fowl, we may suppose it to have its uses. Anyhow, no one but a thoroughly self-satisfied and ignorant person would believe it to be unimportant, because the quantity is small. In **Liebig's beef-tea** it is always met with, as that contains all the soluble constituents of meat which are not removed or obtained by boiling. Thus there is neither albumen nor gelatin in Liebig's extract, but **kreatin** and **inosin**. The kreatin may be likened to quinine; the inosin to sugar. Inosin is also called **muscle-sugar**. It is contained most largely in the heart, and identically the same substance is contained in the kidney-bean. Inosin has a sweet taste, and a chemical composition similar to that of dextrose, except that it contains more water of crystallization.

[KREATIN, $C_4H_9N_3O_2$, H_2O, crystallizes in transparent prisms, which require 75 parts of water for solution. By the loss of water it becomes changed, into KREATININ, $C_4H_7N_3O$, and is thus found in the liquid excretion. INOSIN, $C_6H_{12}O_6$, $2H_2O$, also crystallizes in prisms. When heated below the boiling-point of water, it loses water, and has the same composition as dextrose (par. 41).]

159. Without attempting to enter deeply into the subject, it may be safely asserted that the various **salts** contained in our food are essential to the nourishment of the body; in other words, all foods worthy of the name contain certain salts. **Calcium phosphate**, or **bone-earth**, is necessary to the building-up of the bones. Unless, therefore, our food contains **phosphates**, no skeleton can be formed. Now, as a fact, it may be borne in mind that the albuminoid group of foods contains either phosphorus or phosphates, or

both. **Albumen** and **fibrin** both **contain phosphorus**; **casein** does not, but then it is always associated largely with **phosphates.**

[Neither albumen nor fibrin can be thought of without PHOSPHORUS as an essential component; but if we examine more closely the liquids in which albumen is found, and which change albumen into fibrin, we shall always meet with phosphates. In the juice of flesh, we find **potassium hydrogen phosphate**, and such juice is **acid** to test-paper; but in the blood, which turns **red** litmus-paper **blue**, we find **tri-sodium phosphate.**]

160. In all **vegetables** containing much **nitrogen**, such as the cereals (wheat, oats, barley, &c.), and the leguminosæ (peas, beans, lentils), the albuminoid materials are always accompanied by these phosphates.

161. **Liebig's beef-tea** contains these phosphates most abundantly, and is therefore of great use in the making of gravy, and of soups, where the ingredients which are wanting, such as albumen and gelatin, are otherwise obtained.

162. Besides the phosphates, common salt, or **sodium chloride**, is contained in all juices, especially in the blood. This salt is necessary to the production of **hydrochloric acid** in the gastric juice, and of **soda** in the bile (par. 176).

The power possessed by salt of **preserving** meat is well known; but salting takes somewhat from the nutritive value of meat, because it dissolves and removes in the brine some of the albumen, the phosphates, kreatin, and other valuable ingredients of the juice.

163. All foods containing much starch, as well as all highly albuminoid, should be eaten with salt. **The more thoroughly the salt is incorporated with our food, the better**, and therefore it should be **introduced as such in the process of cooking** (par. 176).

CHAPTER X.

THE CHEMISTRY OF FOOD.

164. STARCHES, SUGARS, and FATS are bodies which consist of the three elements **carbon, hydrogen,** and **oxygen.** CELLULOSE belongs to the same class; so also does alcohol. Without disputing whether alcohol is food or not, although it is held to be such by the author, starch, sugar, fat, and alcohol belong to the **respiratory** or **carbonaceous** class. They are respiratory foods, because they more readily sustain the animal heat; and the more useful, in proportion to the amount of hydrogen unburnt, or requiring oxygen from without.

The **difference** between **starch** and a **fat** is at once seen by comparing the composition of each in 100 parts.

	Starch.		Butyrin.
Carbon	44·5	...	65·2
Hydrogen	6·2	...	11·6
Oxygen	49·3	...	23·2
	100·0		100·0

165. As a **heat-producing agent, dry fat** is **two and a half times as valuable** as the same weight of **starch** or **sugar.** In cold countries the value of fat food is well understood, but it is difficult to persuade young people to place a proper value upon it. In the form of butter and cream, it is generally esteemed, but fat is not sufficiently valued in its property of promoting digestion, and enabling the body to appropriate nitrogenous food.

166. Many articles of food can be made more

effective by the use of some kinds of fat. This is especially the case with the meat of poultry, rabbits, and many kinds of fish, as soles, whiting, plaice, haddock, cod, and turbot. Sprats, eels, herrings, pilchards and salmon are, on the contrary, more or less rich in fat. **Among vegetables**, pease and beans are especially improved by the **admixture** of **fatty food**, and none is more suitable, or more economical, than fat bacon. The richness of good COCOA and of CHOCOLATE is also due to fat, as cocoa naturally contains as much as 50 per cent. of a solid fat known as **cocoa-butter.**

167. The sugars are the main source of **lactic acid**, a constituent of the gastric juice, and best known in sour milk, as giving to the latter its acid taste. Lactic acid has the same percentage composition as lactose, or sugar of milk, and is consequently a compound of carbon with the elements of water. Sauerkraut contains lactic acid. [LACTIC ACID, $C_3H_6O_3$, is a clear, syrupy liquid, of sharp acid taste.]

168. **Albumen, glutin, fibrin,** and **casein** are the most important **nitrogenous constituents** of **food.** To these may be added, but in an inferior sense, **gelatin.** Inasmuch as albumen is the most valuable, the name **albuminous** is often given to this class of foods; **plastic** material is also a changeable term for nitrogenous foods.

The properties of these different compounds are given in Chapters VIII. and IX., and require no repetition. They all of them contain **sulphur** as an essential element (par. 53); albumen, glutin, and fibrin contain **phosphorus**, as well as sulphur.

169. [SULPHUR, S, is an element well known in its free state. In commerce it is met with as brimstone, and it is much valued as a medicine, under the name of flowers of sulphur. When pure, sulphur is of a

pale yellow colour, heavier than water, and quite insoluble. It melts at 150° C. When further heated in air, or in oxygen, it burns into SULPHUROUS ACID, SO_2, a gas possessed of most suffocating odour. An important fact remains for consideration. All articles of food which contain sulphur are liable to become corrupt and abominable, injurious to health, and offensive to the sense of smell. Hydrogen unites with the sulphur of albuminoid bodies, especially in absence of air, and forms the offensive and injurious gas known as HYDROGEN SULPHIDE, H_2S. Because emitted from a putrid egg, it is commonly called **rotten egg gas.** Care should therefore be taken not to allow any refuse to accumulate from which this gas can be emitted; and this remark applies not merely to the accumulation of refuse animal, but also vegetable matters. As regards the former, the dressing of meat is left to the butcher; but, as regards vegetables, how much better it would be for the community if they were as carefully trimmed before brought to market, or, at least, into our homes. The chief contamination of the air by our dust-bins would then be avoided, as the refuse vegetables are the main cause of the nuisance, and the necessity for removal would be obviated.]

170. [PHOSPHORUS, P, is also an element, but never found in nature in the free state. It is a pale, wax-like, lustrous solid, nearly twice as heavy as water, and, like sulphur, insoluble. It melts at 44° C., and should always be handled under water, because so inflammable.

Phosphorus forms a compound with hydrogen, called HYDROGEN PHOSPHIDE, PH_3, a gas possessed of the smell of putrid fish. This gas is given off in the putrefaction of albuminoid bodies. It may be produced by boiling phosphorus in a solution of caustic potash (fig. 19); at the same time a very small

quantity of a liquid hydrogen phosphide is produced, which renders the gas spontaneously inflammable. The appearance is most beautiful, from the formation of widening rings of snow-white PHOSPHORIC ACID, P_2O_5.]

Fig. 19.

171. Although **casein** does not contain phosphorus, it always removes from milk **phosphate** of **lime**, the chief constituent of **bones** (par. 150). Nitrogenous matters always contain either phosphorus or phosphates, and are necessary for the repair of tissue.

172. The following table gives, with some approach to accuracy, the amount of **nitrogen** which could be afforded, respectively, by **one pound weight** of different articles of food.

Nitrogen per lb.

	In grains.		In grains.
Skim-cheese	364·	Fat pork	106·
Ordinary cheese	315·	Bread, wheaten	90·
Roast beef	260·	Pearl barley	90·
Pease	252·	Average bacon	80·
Red herrings	217·	Rice flour	68·
Boiled lean beef	215·	Milk	44·
Boiled mutton	190·	Potatoes	24·
Oatmeal	140·	Beetroot	17·
Wheaten flour	120·	Whey	15·
Maize	120·	Cabbages	14·

173. It does not follow, for instance, that one pound of roast beef should really afford 260 grains of nitrogen to the system. The whole of it would not be assimilated; but the student may obtain from such a table a notion of the quantity of nitrogen which each pound could give under the most favourable circumstances.

174. It is very important properly to adjust the admixture of foods, so that the plastic should not be much in excess of our wants, as regards nitrogen, and also that the carbonaceous or respiratory should be in fair proportion. The nitrogenous may be in the proportion of one-fourth to one-sixth of the respiratory or carbonaceous food.

175. Now the quantity of nitrogen in food must not be mistaken for nitrogenous or nitrogen-yielding food. As has been already stated, all nitrogenous food consists of at least five elements; viz., carbon, hydrogen, nitrogen, oxygen, and sulphur; and, in the case of albumen, glutin, and fibrin, with addition of the element phosphorus.

176. If our food consisted of these elements alone, the act of combustion would convert them entirely into gaseous compounds, and they would pass, as such, into the air. But it is a well-known fact that an ash is left, when food is burnt; and the more of plastic food there is, the greater is the amount of ash. Thus, pease and lentils, when burnt, leave 2·3 per cent. of ash, and these are notedly high in their standing among plastic foods. About 70 per cent. of the weight of a bone (par. 150) consists of incombustible ash. In the juice of flesh we find phosphates (par. 159), and an abundant supply, when required, in Liebig's beef-tea (par. 161). Common salt, too, or sodium chloride, which is found in every secretion, constitutes about one-half of the weight of the ash of blood. Its constant presence in all animal and vegetable fluids, and in the ash of every kind of natural food, shows the importance of a proper supply. A grown man requires from 150 to 200 grains of salt per day.

All vegetables should be salted before they are cooked, as they are thereby rendered more tasty and

more wholesome. Not that the quantity of salt in the blood is increased by the salt we eat, but we find digestion promoted by its presence.

[SODIUM CHLORIDE is a compound of the metal SODIUM or NATRIUM, Na, with CHLORINE, Cl. The chemical symbol for salt is therefore NaCl. By the action of vitality, the sodium chloride, in presence of water, is broken up into HYDROCHLORIC ACID, which is found in the gastric juice, and into SODA, or SODIUM OXIDE, which is a component of the bile. The same compound, SODA, may be produced by burning sodium under water, as suggested in the experiment represented by fig. 20. The test-tube *b*, held in the left hand, and previously filled with, and kept with its mouth under water, becomes filled with hydrogen when a piece of sodium fastened to a wire is allowed to enter the water in the basin *a*; the water is driven out of the tube into the basin, and soda is found in solution, in the place of the insoluble metal.] LIEBIG says that, for all purposes of nutrition, a diet free from salt is no better than eating stones. With abundance of nitrogenous matter, absence of salt is equivalent to starvation. **Excess in food is much less injurious when we partake freely of salt**, and it is of first importance that choice of salt at meals should not be left to the young.

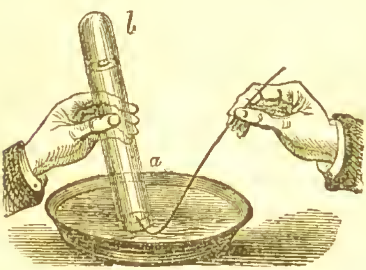


Fig. 20.

Oxide of iron is always contained in the ash of blood and of muscle, and also, in minute quantities, in the ash of milk. Defect in iron has often to be supplied by medicine, as it is necessary to the making

of blood and muscle. Certain meats, as veal and fish, are deficient therein, and the want must be made up by vegetables and bread.

177. It is obvious that, whilst the study of Chemistry will give us the necessary knowledge of the composition of food, it requires experience to guide us. Defect here, and excess there, can only be remedied by proper admixture. Want of space will only allow of indications as to what we should eat and what we should drink.

CHAPTER XI.

THE DRINKS OF THE BREAKFAST-TABLE.

178. After the detailed account of water, as an article of food, given in Chapter I., a few words will suffice concerning its special relations to the breakfast-table.

179. For making tea or coffee, the water must be absolutely boiling hot. Now water is said to boil when the steam which comes from it has the same elasticity as the air; so then, boiling depends upon atmospheric pressure, and may be higher or lower than 100° C., according as the pressure is raised or diminished.

180. If water be very hard (pars. 11 and 12), either thoroughly boiled water should be employed, or water just on the boil; that is to say, either water from which carbonate of lime has already been separated, or hard water only just boiling, before the separation of carbonate of lime has commenced.

181. All vessels in which it is desirable to keep the

water hot, such as the tea-kettle and tea and coffee-pots, should be as **bright** and burnished as possible. The Scotch fashion of covering the teapot with an ornamental loosely-fitting wrapper, or "cosy," is to be commended, as it keeps in the heat for a long time.

182. The introduction of **tea** has been one of the greatest boons to European nations. It has tended greatly to diminish the use of spirituous liquors, and has therefore largely contributed to promote temperate habits. According to BECKMANN, tea was first introduced into Europe by a Russian embassy, at the commencement of the seventeenth century. The plant is a **native** of **China**, and of the Northern provinces of Hindostan. It also grows abundantly in Japan and in Cochin-China. Its cultivation is carried on over large tracts of country. The **shrub** in cultivation about Canton is known to botanists as **Thea bohea**, while the more northern variety, from which the green tea is made, has been called **Thea viridis**. Both black and green teas can, however, be made from either at the will of the manufacturer. There are, of course, many varieties: for, as the tea-plant is multiplied by seed, it is not to be expected that the produce should be altogether identical with the parent.

183. The young **tea-plantations** are made in spring, and are well watered by the rains which fall at the beginning of the summer monsoon in April and May. When seen at a distance, it looks like a shrubbery of evergreens; the leaves are of a rich dark green, and afford a pleasing contrast to the strange and often barren scenery around. The tea-plant belongs to the same family as the well-known **Camellia**; but it is in every way smaller, and the leaves less thick and glossy. The young plantations are allowed to grow

unmolested for two or three years, the natives being aware that the practice of plucking the leaves is very prejudicial to the health of the shrubs. The length of time which a plantation will remain in full bearing depends on a variety of circumstances, but, with the most careful treatment consistent with profit, the plants will not do much good after they are ten or twelve years old: they are often dug up and the space re-planted before that time.

184. In the making of green tea the leaves are spread out thinly on flat bamboo trays for the course of an hour or more, in order to drive off all superfluous moisture. In the mean time the roasting-pans have been heated with a brisk wood fire. A portion of leaves are now thrown into each pan and rapidly moved about, and shaken up with both hands. They are immediately affected by the heat, begin to make a crackling noise, and become quite moist and flaccid, while at the same time they give out a considerable portion of vapour. They remain in this state for four or five minutes; they are then drawn quickly out, rolled up in balls, compressed, to squeeze out their moisture, and then again thrown into the pan. Here the leaves are kept in rapid motion by the hands of workmen. In about an hour or more they become well dried, and their colour, which naturally is of a dullish green, is permanently fixed.

185. If, however, the leaves are to be converted into black tea,—first, they are allowed to lie spread out in the factory for some time after being gathered, and before they are roasted; secondly, they are tossed about until they become soft and flaccid, and then left in heaps; thirdly, after being roasted for a few minutes and rolled, they are exposed for some hours to the air in a soft and moist state; and, fourthly, they are at last dried over charcoal fires. The difference

in the manufacture of **black** and **green teas** is therefore most marked.

186. This is a description, culled from Mr. Fortune's work on China, of the manufacture of tea as it ought to be sold in the British market. But its adulterations are as numerous as they are for the most part harmless.

187. The **properties** of tea depend chiefly on the presence of a **volatile oil**, and of **thein**, together with **tannin** and certain **salts**.

188. As the **volatile oil** is **easily lost**, and acts as a powerful stimulant, tea should be **infused**, and never boiled. In China, it is true, the dried leaf is not used until, by keeping a twelvemonth, it has lost much of this oil; but there is no fear to us from the presence of too much oil, which at the utmost, amounts to 0·8 per cent. in green tea. The aroma is best brought out by placing the leaf in a pot, heating it before the fire, and then filling up with boiling-hot water.

189. **Tannin** (par. 102) in tea may amount to as much as 18 per cent. It is a very powerful astringent. The quantity of it in the infusion depends upon the length of time the tea is allowed to draw: **hence it is advisable to pour the made tea into a second pot, if it is to be kept for a length of time.** Would that the caterers at our places of public entertainment would bear this in mind, for nothing can exceed the mawkish taste of the article there offered, or furnish a better excuse for taking alcoholic drinks!

190. But the valuable properties of tea, next to the essential oil, depend upon the presence of **thein** (par. 197), which exerts a stimulant and a tonic action upon the nerves, resulting in a general feeling of refreshment and invigoration. In delicate and nervous persons strong tea produces wakefulness and restless-

ness, often with palpitation of the heart, and other symptoms of distress.

191. Cold tea makes an admirable summer drink, and affords one of the best methods of employing London water after it has been boiled. The celebrated Dr. Johnson says that he is a hardened and shameless tea-drinker, who for twenty years diluted his meals with only the infusion of this fascinating plant; whose kettle had scarcely time to cool; who with tea amused the evening, with tea solaced the midnight, and with tea welcomed the morning.

192. The taste for coffee is in England not so general as that for tea. It was first introduced amongst us in the year 1652, when a coffee-house was established in London by a Greek in the neighbourhood of Cornhill.

193. Coffee belongs to the same natural family which supplies us with ipecacuanha, quinin, and cinchonin. The plant is a native of the Ethiopian highlands, and is now extensively cultivated in Arabia, the East and West Indies, and America. It is an evergreen, and grows to a height of about 16 feet. The leaves are oblong-ovate, sharp-pointed, very glossy, and upwards of $2\frac{1}{2}$ inches long. The flowers are white and fragrant, but fade rapidly. Fig. 21 gives a good representation of the coffee-plant: *a*, corolla and stamens; *b*, style and stigmas; *c*, the berry, and *d*, the berry with the two seeds exposed. The fruit somewhat resembles the cherry, and grows like the flower, in clusters; when ripe it is shaken from the tree, and laid on mats exposed to the sun. As soon as it is dry, it is spread upon a floor, and the husks are broken off with a heavy roller. The berries are then winnowed, and further exposed to the sun. Each shrub will afford from one to two pounds of the

berry. Mocha coffee is the most highly esteemed, and affords the most agreeable beverage.

Fig. 21.

194. Coffee **swells** greatly during roasting, and **loses** about 20 per cent. of its **weight**. It becomes brown and friable, and exhales a rich aroma; at the same time a pleasant bitter principle is produced, which is not contained in the raw coffee. The **sugar** in coffee amounts to upwards of seven per cent. and is of the same character as sucrose. Ordinary roasted coffee contains **caramel** (par. 38), derived partly from the natural, and partly from added sugar.

195. The **aroma** acts as a stimulant, and the effect of an overdose is similar to that of oil of tea; and yet coffee only contains 0·003 per cent.! There is no **tannin** in coffee, but in its place a peculiar **acid**, the **caffeic**, which is a variety of tannin in combination

with caffein. In making coffee, if an agreeable flavour be desired, the berries should have been freshly roasted, finely ground and infused: it is then less astringent, less acid and more digestible; but, owing to the large quantity of fixed fat (13 per cent.), coffee is not so easily digested as tea.

196. A cup of strong coffee is far more stimulating than tea; when taken freely, it produces dryness of the skin, thirst and feverish symptoms. The effect on the brain is striking. It prevents drowsiness; hence is it called by the French "liqueur spirituelle." It accelerates the circulation of the blood, and sometimes occasions giddiness and palpitation of the heart. In tropical climates it is valued for its stimulating powers, being regarded almost as a specific against the enervating effects of heat.

Liebig says of coffee: "Persons of weak or sensitive organs will perceive, if they attend to it, that a cup of strong coffee after dinner instantly checks digestion. It is only when the absorption or removal of it has been effected, that relief is felt. For strong digestions, which are not sufficiently delicate reagents to detect such effects, coffee, after eating, serves, from the same cause, to moderate the activity of the stomach, exalted beyond a certain limit by wine and spices. Tea has not the same power of checking digestion."

197. Thein in tea, and caffein in coffee, are identical in chemical composition, and are active alkaloids, like quinin. In tea, it may amount to 3 or even 4 per cent.; in coffee to less than one (0·8) per cent. It crystallizes in long, white, silky needles, sparingly soluble in cold water and in alcohol. When heated, it fuses and sublimes, and for this reason may often be extracted from coffee-roasters. The effects of this alkaloid are a result of a stimulant and tonic action

on the nervous system generally. [THEIN, $C_8H_{10}N_4O_2$, H_2O, is identical with CAFFEIN, $C_8H_{10}N_4O_2$, H_2O.]

198. **Cocoa** and **chocolate** are not sufficiently valued as articles of diet. Although in one important respect resembling tea and coffee (with regard to the alkaloid **theobromin**), they are both meat and drink in the way of direct nutrition. The name of the cocoa-tree, *Theobroma cacao* would seem to embody the opinion of the great botanist LINNÆUS as to its value; the word Theobroma signifying "food for gods." According to JOHNSTON, it grows wild in several countries of the torrid zone of America, especially in Guiana, Mexico, and the coast of Carraccas. The tree has large leaves, and the flowers grow on short stalks direct from the stem. The fruit is a large leathery capsule, having nearly the form of a cucumber, and containing from twenty-five to thirty seeds. These are covered with a thin husk, which is removed before the seeds are broken into the familiar form of **cocoa-nibs**.

199. The nibs yield about 55 per cent. of **cocoa-butter**, a white, solid fat, not liable to become rancid. In the so-called homœopathic cocoa this fat is entirely removed. The nibs also abound in glutin (par. 129), to the extent of 17 per cent.; but this is almost entirely removed in the ordinary mode of preparing cocoa. Gum, sugar, starch, and cellulose amount to 22 per cent.

200. **Theobromin** in cocoa amounts to about 1·2 per cent. In composition it closely resembles caffein and thein, and has similar properties. [THEOBROMIN, $C_7H_8N_4O_2$, is an alkaloid, slightly bitter in taste, sparingly soluble in boiling water, and still less so in alcohol and ether.]

201. **Chocolate** is generally prepared by grinding the roasted nibs into powder between hot rollers.

This powder is made into a paste flavoured with vanilla, sweetened with sugar, and generally deteriorated with flour or starch. HUMBOLDT gives this testimony in favour of chocolate, that, before the conquest of Mexico, it formed the principal food of the Mexicans. They held the cocoa-tree in such estimation, that its kernel served as current coin; and this custom still continues. By being mixed with milk, as it generally is, it is made still more palatable as well as nutritious, and is strongly recommended as an adjunct of the breakfast-table.

202 As the late Professor JOHNSTON remarks: "Everywhere, in fact, un-intoxicating and non-narcotic drinks are in general use among tribes of every colour, beneath every sun, and in every condition of life. The custom, therefore, must meet some universal want of our nature, some physiological function which science has not explained; and, considering that these beverages contain essentially the same chemical compounds, it is remarkable that they should have been selected from the whole range of the vegetable kingdom. What constitutional cravings common to us all have prompted to such singularly uniform results! Through how vast an amount of unrecorded individual experiences must these results have been arrived at! Coffee has followed the banner of the Prophet wherever, in Asia or Africa, his false faith has triumphed. Tea, a native of China, has spread over the hill-country of the Himalayas, the table-lands of Tartary and Thibet, and the plains of Siberia; has climbed the Altais, overspread all Russia, and is equally despotic in Moscow as in St. Petersburg. In Central America, the Indian of native blood, and the Creole of mixed European race, indulge alike in their ancient chocolate. In Southern America, the tea of Paraguay is an almost universal beverage."

203. One **advantage** of all these drinks consists in the great fact that they must always be made with **boiling water**, and thus provision made for the great want of many places, a wholesome drinking-water. One thing should be remembered in connection with the use of hot beverages: not to speak of the damage inflicted on the teeth by repeated alternations of hot and cold, excessive heat materially impairs the digestive power of the stomach, permanently weakening its structure. It is a matter of common observation, that cooks are noted for bad teeth. This may be accounted for from their love of hot tea, and their opportunities for eating scalding-hot food.

204. The very **best beverage** for breakfast and tea for children is **milk**, in some form or other. With the prevalence of foot-and-mouth disease, and the possible adulteration with tainted water, **it should always be boiled.** The same may be said of **skim-milk** as a common drink for adults in the place of water.

205. It may be necessary to repeat that skim-milk contains all the **plastic material** of fresh milk, and has only been deprived of the greater portion of its fat. It is a most valuable article of food.

CHAPTER XII.

FRUITS, A VARIETY OF DRINK.

206. All fresh fruits contain much water, and may be regarded as acid juices more or less sweetened,

with more or less of nutriment. If not perfectly ripe, fruit should always be cooked before it is eaten; else it is unfit for food. Unripe fruit may be compared to bad water, laden with organic matters in a state of change, the evil effects of which can only be destroyed by heat. More especially is this the case with fruits like the melon, which contains 96 per cent. of water: except when ripe, it should never be eaten, and, like all watery fruits, should be eaten with bread, so as to separate the tough cellular structure, to prevent its forming indigestible pads.

207. The **apple** is both wholesome and nutritious. The tree itself, *Prunus malus*, is a native of Britain, being far from uncommon in woods and hedges, though the wild apples or crabs are small, dry, sour, and unpalatable. By sowing and re-sowing the seed, crossing and re-crossing the sorts thence produced, the many known **varieties of apples** are procured. Heat, when applied in roasting, baking, or boiling, tends to break down the interstices of the cells of the apple, to diffuse the acid and the sugar more uniformly through the mass, to disperse some of the moisture, and to render the whole more easy of digestion.

208. One of the properties of sugar is especially worthy of remembrance, when the sweetening of a fruit-pudding or pie is in question. The **presence of vegetable acids** (pars. 98, 99, 100) soon determines the **change of sucrose** (par. 36) into **dextrose** (par. 41),—a sugar possessing far less of sweetening power. It is consequently a waste of a portion of the sugar to sweeten before cooking.

209. The **pear** grows wild in our woods and copses, but it there yields fruit of a very inferior description, and very unlike the juicy produce of the orchard. From a deficiency of acid, this fruit is less wholesome

for delicate stomachs than the apple. In both cases, where health is studied, the **skin** as well as the **core** is to be rigidly **avoided.**

210. **Black** and **red currants** are natives of Britain, as are also **gooseberries.** Cold as are some of the countries of Northern Europe, large and beautiful berries may be obtained. Even in the barren districts of Finland, and on the Alpine heights, gooseberries with ruddy tints have been met with. A traveller in Kamschatka found himself in a large forest, many of the trees being finely grown; and amongst the underwood he perceived some bushes of large red berries, which, to his great astonishment, he discovered to be red currants of a very large size and high flavour, but possessing a much more acid taste than those of our gardens.

211. **Cherries** were obtained from Cerasuntis, a city of Pontus, in Asia Minor; hence the botanical name, *Prunus Cerasus.* Lucullus, after the war with Mithridates, introduced them into Italy: they were so pleasing as to be rapidly cultivated, and Pliny testifies that, twenty-six years afterwards, the cherry-tree passed over into Britain. The whole race of this tree was afterwards lost, and is said to have been restored by the gardener of Henry VIII., who brought it from Flanders.

212. Just as the cherry has become indigenous, the **plum** is common in its wild state, and has been much improved by cultivation. The **sloe** may be the original stock from whence all the varieties of the plum have originated.

The **damson,** or damascene, was brought from Damascus. The most unwholesome portion of wall-fruit is the skin, which is quite as indigestible as wood.

213. Ripe **grapes** are among the most palatable, wholesome, and nutritious of all fruits. The weight

of grapes which every vine can properly produce is proportioned to the thickness of the stem immediately above-ground. At Hampton Court there is a vine which yields about fourteen hundredweight of very fine grapes in a good year. The grapes produced in Palestine are very large; the famous bunch of Eshcol, which required to be borne by two men, greatly surprised and pleased the Israelites when they first beheld in a barren and sandy desert, the fruits of the long-promised land they were to occupy. Even now, in the present neglected state of the country, some bunches of grapes are found to weigh twelve pounds.

214. The quantity of sugar in the grape is very large, varying from 10 to 20 per cent. Dried grapes or **raisins** are greatly valued. The so-called Muscatel raisin consists of the bunch dried whilst yet hanging on the vine. **Sultanas** come from Turkey.

215. Although of less importance to us in England, the **date** is of great value throughout Asia and Africa. It is the fruit of a palm, and sweet to a high degree, from the presence of 58 per cent. of sugar.

216. The **fig** is the sweetest of fruits, and comes from one of the most beautiful of trees. It is apt to cloy.

217. **Mulberries** bring us back to juicy fruits. They contain 85 per cent. of water and 9 per cent. of sugar, and sufficient acidity to be pleasant to most palates.

218. **Strawberries** and **raspberries** are about equal as to water, but the former are always sweeter, and contain less free acid. Both fruits are very refreshing, and much appreciated.

219. Amongst the most useful and grateful of fruits introduced to us in modern times, is the **orange**. The Portuguese are supposed to have imported it into Madeira, and into all countries washed by the Mediterranean. No single kind of food has had so much to do with the removal of scurvy as this deli-

cious fruit, together with its allies, the lemon and the citron.

220. Many of these fruits contain a notable quantity of sugar, nitrogenous matter, acids, and salts, as may be judged from the following table, compiled from the labours of FRESENIUS :—

	Water.	Sugar.	Acid.	Nitrogenous matters.	Salts.
Mulberries...	85·0	9·0	1·86	0·40	0·56
Grapes	79·8	13·8	1·12	0·80	0·12
Blackberries	86·4	4·4	1·18	0·50	0·41
Pears	85·0	8·0	trace	—	0·28
Apples	85·0	7·5	1·04	—	0·44
Cherries......	80·5	8·7	1·27	—	0·56
Strawberries	87·4	7·5	1·13	0·36	0·60
Raspberries	86·5	4·7	1·35	0·54	0·48
Gooseberries	85·5	8·0	1·35	0·44	0·31
Currants ...	85·2	6·4	1·84	0·49	0·57
Greengages	79·7	3·4	0·87	0·40	0·40
Apricots ...	83·5	2·7	1·60	0·41	0·72
Peaches......	85·0	1·6	0·60	0·46	0·42

The nitrogenous matters in pears, apples, and cherries are not stated. The quantities of water and of sugar vary according to season, &c. But the analyses will convey a useful lesson as to the composition of many fruits. When in season, these fruits may be made to supply substitutes for alcoholic drinks and tainted water.

Indeed, fruit is the most natural, healthful, and delicious part of our diet, and ought to form a much larger proportion of it than is usual, especially among the poorer classes. Preserved fruits are to be obtained at very reasonable prices, and, thanks to the removal of the duty on sugar, are now generally sold free from adulteration.

Bread and butter should be eaten with ripe fruits, if they are to serve the purpose of nutrition, and the part of a meal.

CHAPTER XIII.

VEGETABLES, AND THE PART THEY PLAY AS FOOD.

221. It has probably been observed that flesh, corresponding in composition to that of the human body, contains 79 per cent. of water. **Now the liquids taken at a meal should be in quantity, such as, when added to that contained in the solid food, would raise the whole amount to this percentage.** In fact, however, instinct urges us usually to take more than the above-prescribed dose. On this point the conclusions of pure chemistry must not be too rigorously interpreted. Genuine science need never override common sense and experience, which must be allowed some sway, not to contradict, but to modify, if need be, and reduce to their true value the dictates of science.

222. **Every kind of natural food is bulky**; that is, it contains much that is not in the ordinary sense nutritious. Vegetables, for example, contain a very large proportion of water and woody fibre: bulk seems, however, essential to the proper action of the stomach, which cannot digest more than a very limited quantity of concentrated nourishment. This is one reason why pease and beans are not readily digested in any quantity, their nitrogenous matter being too abundant.

223. Of foreign vegetables now established among us, many originally came from Southern climates, especially from Italy, and the number of them has greatly increased in the course of the last two centuries. The kitchen-gardens of England were, until about the end of the sixteenth century, as scantily supplied with vegetables as the pleasure-grounds were with shrubs and flowers. "It was not," says Hume, "till the end of the reign of Henry VIII., that any

salads, artichokes, carrots, turnips, or other edible roots, were produced in England." The little of these vegetables that was used, was imported from Holland and Flanders; and Queen Catherine, when she wanted a salad, was obliged to despatch a messenger thither. The most important vegetable of the present day, the **Potato**, was brought to England in 1586, by Sir Walter Raleigh; but its culture for the next century must have been but partial, as the market-price was then one shilling per pound. **Brocoli** and **Cauliflower** were introduced from the Levant into Italy about the end of the sixteenth century, and at the close of the seventeenth into England. The **Turnip** was in cultivation in the seventeenth century; and it is stated that when in the years 1629 and 1630 there was a dearth in England, very good bread was made with boiled turnips, kneaded up with an equal quantity of wheaten flour.

Among the kitchen vegetables, of which uncertain traces are to be found in the works of the ancients, is **Spinach.** Its native country is unknown. The name first occurs in the year 1351 among the lists of food used by the monks on fast-days. The extent to which the Romans carried their enthusiastic affection for **Leguminous** * plants, is shown by the fact, that illustrious families did not disdain to borrow their names from them. Fabius, Cicero, and Lentulus thus give renown to the humble names of beans (Faba), pease (Cicer), and lentils (Lenticula).

224. **Potatoes** deserve, perhaps, chief mention amoug ordinary vegetables. They contain, it is true, 75 per cent. of water when raw, but this very succulence adds to their value. They should be cooked in their skins, as they thus not only lose but little moisture

* *Leguminosæ* is the botanical name for the family to which pease, beans, lentils, &c., belong.

(3 per cent.), but are then more easy to **steam**, and more mealy when brought to table. The starch which they contain is a first-rate vehicle for salt, and a good absorbent of fat. Except when eaten in large quantities (which is as objectionable as making rice a chief portion of diet), they cannot afford the nitrogenous (par. 47) materials in anything like sufficient quantity, unless eaten with fish or flesh, or with highly nitrogenous food like eggs, pease, and beans. With skim-milk as a drink they do well; in fact, all they need is admixture with more nitrogenous food, of which potatoes contain only 2 per cent. It would require about $3\frac{1}{2}$ lbs of cooked potatoes to supply the same amount of nitrogen as can be obtained from one pound of good wheaten bread.

225. As regards the **cooking** of potatoes, it is necessary to add a word; they should **not be boiled**, but **steamed.** Waxy potatoes should, if bought, be somewhat dried before they are steamed, by placing them in the hot ashes. If peeled, they lose 14 per cent. of water; a matter of no great importance in itself, as potatoes contain so large a quantity, but serious to the poor, because so much waste is incurred in the act. When steamed in their skins, they should be scrupulously clean; and if the cook does not possess a steamer, the principle may be carried out by placing only a small quantity of water at the bottom of the saucepan, and with closed lid allowing the **steam** to do the work. **Baked potatoes** are somewhat more nutritious than steamed, as they lose more water, and they are certainly more wholesome.

If persons are at all delicate, **potatoes** should always be served **mashed**, as it is a great mistake to suppose them easy of digestion unless well masticated. Underdone potatoes are among the most objectionable forms of food.

226. **Cabbages,** although in themselves of little value as food, are of great importance in admixture. As the common cabbage contains about 92 per cent. of water, it occupies a lower rank as a vegetable than the potato ; its succulence is, however, a great recommendation, especially when eaten with dry salt meats, which supply the necessary nitrogen ; or with bacon, which makes it rank high as respiratory food ; thus is the requisite bulk obtained at no great cost. With regard to nitrogenous matters, the cabbage stands upon exactly the same level as the potato.

In Germany, cabbage is made into very nutritious food by the introduction of boiled chestnuts ; these are peeled, rasped, mixed with the cooked cabbage, and flavoured with butter and salt.

227. **Carrots** and **turnips** are about of similar value as to nitrogenous matters ; that is to say, they are equally low. Turnips contain only 2 per cent. of sugar ; carrots 6 per cent. In other respects, when tender, they are about equally digestible. Owing to the large amount of water which they contain, they are well suited for admixture with salt meat. **Parsnips** are about intermediate between carrots and turnips.

228. **Beet-root** stands higher as respiratory food than carrots, on account of the considerable amount of sugar which it contains. But, as to nitrogen, its value is small, even less than that of a potato. One pound of beet-root would be equal to one moderate-sized egg, with reference to nitrogen. Nevertheless, it is an admirable vegetable when boiled, cut in slices and served hot, with thick gravy or melted butter.

229. **Onions,** to those who do not dislike their odour, are admirable as giving flavour to many foods which would be otherwise tasteless and unsatisfying. The Spanish peasant dines frequently on bread and raw

onion; and, although this is not suggested for imitation, it is worthy of record as a fact. A very small piece of meat may be made serviceable to many mouths, by admixture with certain vegetables flavoured with onions. If the water in which the onions are boiled is thrown away, and renewed more than once, much of the strong-smelling and indigestible oil is removed, and the chief offence done away.

230. Lastly, onions suggest **cucumbers**. These are least unwholesome when cut at the time they are eaten. No plan of preparation is worse than that of cutting them into thin slices, allowing the juice to drain, and then to serve them with vinegar, salt and pepper. Cucumber salad is then often most indigestible. The large amount of water which it contains makes cucumber a pleasant accompaniment with bread and cheese, especially when freely eaten with salt.

231. It will be expected, in speaking of vegetables, that something more should be said about those which contain less water, and therefore stand higher as regards nutrition. We should distinguish between such as are real substitutes for meats, on account of their high nitrogenous values, and such as turnips, parsnips, carrots and cabbages, which afford a pleasant form of water, some bulk, and but little nourishment. Thus **pease, beans,** and **lentils** stand very high as nitrogenous foods, and should be eaten for the purpose of economizing the more expensive meats. However well cooked, they are not so digestible as meat; they are not only too dry, but too nitrogenous.

They all contain a large percentage of starch, and therefore take rank not only as **plastic** (par. 104), but also as **respiratory food**. Nevertheless, the nitrogenous is so very considerable, that such require large admixture with other kinds of food. Pease and beans, when properly cooked and eaten in moderation, go

well with bacon, fat pork, and potatoes. Hence, also, melted butter is used with them, as it renders the starch more palatable.

Green pease, French beans, and **Scarlet runners,** are much more easily digestible than when in the form of dried pease and beans: one pound of pease may afford 252 grains of nitrogen. Pease meal is best employed in making soup, puddings, and such-like, and is a much-valued article.

232. The reader must have missed his way if he has not perceived that **vegetables contain plastic and respiratory material** of similar quality to that which is met with in animal food. Flesh has its counterpart in the casein of pease, beans, and lentils; in the glutin of bread, and in the fibrin of oatmeal. The fat of meat is represented by the various starches, the sugars and cellulose. The very juices of meats have a certain counterpart in the juices of vegetables. Anyhow, vegetables ought to form a considerable proportion of our food, including, of course, bread and its like, as important and primary articles.

233. But, inasmuch as **vegetables** of every kind **are less digestible than many,** even most, **meats** when properly cooked, persons with small appetites ought to make animal food the leading principle in their diet. And again, all who have a tendency to become stout should be very careful as to their choice of vegetables, and should avoid the starchy constituents nearly as much as the different fats and oils.

234. Considering the enormous number of aliments in the world, and the present great facilities of intercommunication, it is wonderful that so little variety is met with in the dietaries of the poor. For, to a certain extent, the gratification of the appetite is not only a legitimate pleasure but a veritable duty, as it conduces to the health of the body. Most persons are aware of

the appetizing effects of a diet grateful to the palate, and there is nothing more acceptable than frequent change. The strongest illustration is afforded by the positive disgust created by the constant use of the same food, which is indeed so great that, even when it is eaten, the stomach refuses to digest it.

235. Even though it may involve a repetition of certain statements, the following quotation will aptly conclude this chapter, showing, as it does, the importance of proper admixture, and the value attaching to vegetable as well as to animal food.

"It is obvious," says LIEBIG, "that by a due admixture of plastic and respiratory food, we can obtain a diet of a composition analogous to that of milk or of wheaten bread. By the addition of bacon or fat pork to pease, beans, or lentils; of potatoes to beef; of fat bacon or ham to veal; of rice to mutton; we increase in each case the proportion of non-nitrogenous matter. A glance at these relations is sufficient to convince us that, in choosing his food (when a choice is open to him), and in mixing the various articles of food, man is guided by an unerring instinct which rests on a law of nature.

"This law prescribes to man, as well as to animals, a proportion between the plastic and non-nitrogenous constituents of his whole diet, which is fixed within certain limits, within which it may vary according to his mode of life and state of body. This proportion may, in opposition to the law of nature and instinct, be altered beyond these limits, by necessity or compulsion; but this can never happen without endangering the health, and injuring the bodily and mental powers of man."

CHAPTER XIV.

ON FISH, FLESH, AND FOWL: MODES OF COOKING. COLD MEATS AND SALADS.

236. THE **introduction of fish**, as part of our diet, is very much to be commended. But it is **not fitted** to take the place of flesh-meat **entirely**, except once or twice a week. Salmon, being a red-blooded animal, does not indeed differ much from meat, but it requires greater skill in cooking, and the employment largely of butter and eggs, to make fish generally a substitute. **Fish digests very rapidly**, and soon leaves a sense of emptiness, which is far from pleasant to a hard-working man. Nevertheless, to those who live well, it would be of considerable advantage to make a fish-dinner, at least occasionally.

237. Where the **fat** in fish is fairly **diffused** throughout the muscular portion, the meat is more satisfying; but when the fat, as in cod-fish, is mainly stored up in the liver, and the meat is very dry, a rich butter is required to make the dish perfect. Oyster-sauce, the most nutritious of dressings, generally accompanies cod, and gives to it that which it lacks. What **differences in respect to fat**, there may be in the varieties of fish, the following table will make manifest. The statements are according to PAYEN, and give the quantity per cent.

	Fat per cent.
Soles	0·248
Whiting	0·383
Conger-eel	5·021
Mackerel	6·758
Eels	23·861

Sprats, herrings, and **pilchards** are also **rich in fat**, and are rightly much esteemed, on account of their tastiness and nutritive value. Indeed, fresh, as well as salted, herrings are among the most valued of foods, on account also of the quantity of **nitrogen** which they can afford. A dried herring will give as much as 40 grains of nitrogen, and a fresh one, of average size, about 30 grains; so that a bloater is a good addition to bread-and-butter at the breakfast or supper table.

238. The **fresher** the fish, the more digestible it is. It only requires some judgment to know when certain kinds are in season, and to purchase accordingly. Then alone are they probably in the best condition for eating; and then alone can they be considered economical food. When the flesh is firm, fish-meat is in its highest condition.

239. As regards **cooking**, the remarks made about the effects of heat upon fat (par. 57), require expansion. The heat of **frying** renders fat most difficult of digestion, and should be avoided in the case of delicate persons. The fried fish, as often sold in the fish-shops of London, is very indigestible: the smell ought to be sufficient to give warning of the act of burning, and of the fact of the decomposition of the fat. And if rancid fat is used into the bargain, it is not easy to express in words the injurious consequences possible to some constitutions. **Broiling** is a good process of cooking, where that is possible; but it involves a clear fire, free from smoke, careful attention in the way of turning, and some good sweet fat, though not at all necessarily butter. Lard is far better than much of the so-called butter which is sold at the present day.

Some people, however, can only eat fish which has been boiled, and such is easiest of digestion, although not so savoury.

240. **Poultry** is perhaps intermediate in value between fish and flesh-meat. It is certainly not so satisfying as flesh-meat, and as a substitute, is too expensive for people of ordinary means. Not that poultry is deficient in nitrogen, but rather in fat, and in iron. The fat is easily supplied, but the fact remains, that what would appear an unnaturally large quantity, would have to be eaten by a person of good appetite in order to produce the sensation of a full meal. On account of the want of fat, boiled chicken is always eaten with melted butter, and generally with fat bacon or pork sausages. Roast chickens and tongue, together with a good gravy from beef, also practically make up for the above-mentioned deficiencies.

As regards **phosphates**, the young meat from fowls is peculiarly advantageous, and superior to that from flesh. The want of **iron** can be made up by good gravy. The part, therefore, of poultry, as an article of diet, can be readily understood.

241. **Ducks** and **geese** are more tasty, but not nearly so easy of digestion. The fat is far more abundant, and is therefore liable to be injured by fire; besides which they possess a strong flavour, not relished by all. Addition of sage and onions, by its stronger flavour, may easily overcome the natural taste, but then such seasoning is not very acceptable, and certainly neither agreeable nor digestible.

242. **Rabbits** resemble poultry, and are as easy of digestion. They also require some addition in the way of seasoning, as they are otherwise very insipid. Fried bacon and sausages are good accompaniments, and make up for defect in fat. If boiled, and served with a good white sauce, or with parsley and butter, the want of fat and flavour is also supplied.

243. As regards flesh-meat, much has been already

said (Chapter VIII.). **Roastmeat is more nutritious,** weight for weight, than **boiled,** because **meat** in **roasting loses more** than in boiling. Beef loses less in weight than mutton, partly because of the less fat contained in it, partly because the flesh is more dense. When beef is lean, it may lose even 30 per cent. in boiling; much, however, must depend upon the absence of fat.

One pound of boiled beef, according to the late Dr. Edward Smith's experiments, may give 215 grains of nitrogen; one pound of roast beef 262 grains. Estimating mutton with its usual amount of fat, one pound of boiled mutton may afford 192 grains of nitrogen.

Lamb is more watery than mutton, and digests more easily. Considering how rapidly lamb grows into mutton, and the serious price of meat, it is more than doubtful whether it should be eaten except by invalids.

244. **Veal,** as generally eaten, having been deprived of the blood and its salts, is less digestible than beef or mutton, and should be served with a good gravy made with gravy-beef, or with Liebig's extract of flesh. The salts lost by the veal could thus be re-supplied; but, whether it be wise first to remove, and then to add what we remove, is for a discerning public to settle. The same objection applies to veal as to lamb, as regards the slaughter of young animals. In the form of roast-veal, properly seasoned, and partaken of with ham in order to supply the want of fat and a harder fibre for admixture, this kind of meat is at its best and is most valued.

Calves' feet afford perhaps the purest form of **jelly.** The latter owes its property to a substance called **gelatin** (par. 148).

245. **Pork** is so much richer in fat than mutton or

beef, and is so much more difficult to masticate on account of the texture of the meat, that even its nitrogen does not go so far, as a nutrient, as the quantity present in it would indicate. One pound of fresh pork is said to contain only 79 grains of nitrogen.

Pickled pork is more digestible than either boiled or roast. The latter is said by Dr. Beaumont to require five and a quarter hours for digestion, whilst pickled will probably be digested in about three hours. Salted, as **ham** and **bacon**, pork offers one of the most agreeable varieties of food.

" There is, however, a greater danger in the use of pork than of any other kind of meat, since, so far as is known, it is more frequently diseased, and the nature of the disease is such as to be very injurious to man. Thus, measly pork is known to have produced fatal results to many of those who have incautiously eaten it; and although the characteristics of the disease may be recognized by those who understand it, they are neither known nor observed by the great majority of the poorer classes. Further, the terrible pest of the small worm called the *Trichina spiralis*, is much more frequent in this than in other kinds of flesh in its uncooked state; and the power which the creature has to penetrate the tissues of the body of those who eat it, has been vividly described by German and American writers.

" Many instances of this terrible disease, isolated or in numbers, have now been recorded, and particularly in Germany. Of 103 healthy people who ate diseased pork which had been made into sausage-meat, at Helstadt, in Prussia, 20 died within a month. . . . In all the fatal cases the worm was found to have penetrated the whole muscular system, and upwards of 50,000 were computed to exist on a square inch."—DR. ED. SMITH on FOODS.

The best precaution against any such mishap consists in **perfect cooking.** There should never be the appearance of raw or underdone meat, either in the case of pork or veal.

246. With reference to **sausages,** they are unobjectionable if their origin can be fairly traced. Certainly meats can thus be made available which would otherwise probably be wasted. It is in sausages that diseased meat would most probably be met with.

247. From the very nature of meats, and from the abundance of nitrogenous constituents, the necessity for the use at the same time of **bread** and of **various vegetables** may be inferred. **Bread** is a necessary of the dinner-table, whether the diet be liberal or lean. From its porousness, and its easy digestibility, it is admirably adapted for admixing with and separating the denser meats. It is, besides, useful in retaining moisture, as well as nutritive in the sense of nitrogenous. One pound of bread contains more nitrogen than a pound of pork, and this element is the most costly to purchase.

248. Such **condiments** as **pepper, mustard,** and **spices** act as stimulants of the digestive organs. They often give an appetite by the flavour they confer upon food, and are certainly aids to digestion.

Mustard is an annual cultivated for the sake of its seeds. There are two kinds, the black and the white, and these are generally mixed together. Although the powdered seed has little odour when dry, in the moist condition it exhales a pungent, penetrating odour, very irritating to the eyes and nostrils. The peculiarity of mustard is, that the essential oil, for which it is so highly valued, does not exist ready-formed in the seed, but is developed on the addition of water. It is even possible to render the ferment, which is present, altogether inactive, by means of

boiling water, teaching the lesson that mustard for the table should be made with warm, but not boiling water. **Oil of mustard** consists mainly of **sulpho-cyanide of allyl**, the chemistry of which compound is too intricate for a work of this kind.

Horseradish is the root of *Cochlearia armoracia*, and is much cultivated on account of its grateful qualities. The fleshy root has a pungent taste, and emits, when crushed or scraped, the odour of mustard. When distilled with water, the same oil as from mustard is developed. Mustard is far more wholesome, as the scraped root may adhere in the same way as the skins of plums, and produce indigestion, if not worse results.

Pepper grows in abundance on the Malabar coast, whence, as well as from the Malay Peninsula, Sumatra, and other islands, it is now imported. The berries are gathered before they are ripe, and dried in the sun : they then become **black** and wrinkled from the drying up of the pulpy part, which covers a round greyish-white seed. **White pepper** is the same berry allowed to ripen, when its pulpy part is easily removed by soaking in water and subsequent rubbing. The essential constituents of pepper are :—an **acrid resin**, a **volatile oil** possessing the flavour of the pepper, and a substance called **piperin**, possessed of the composition, but with none of the properties, of morphia.

249. **Vinegar** has already been mentioned in CHAPTER VI. It is certainly one of the most valuable of condiments, and could least easily be dispensed with. A weak solution of sugar is easily changed into vinegar, through the aid of the vinegar plant (*Penicillium glaucum*) : the same plant will continue to grow, and may be used again and again.

The pleasantest vinegar is **white wine vinegar**. In some form or other it has most wide applications. It

prevents the decomposition of animal and vegetable substances, and enables us to keep mackerel, salmon, and other meats, even in the warmest weather, and at a time when vinegar is most grateful. Cabbage is more tasty when eaten with it, and with **salads** of various kinds it is of first importance.

250. Space is wanting to do much more than mention **salads** as a pleasant variety of food, as helping to give bulk in an agreeable form, and in eking out small quantities of meat.

From time immemorial the **lettuce** has occupied a most distinguished place in the kitchen garden. The Jews eat it, without preparation, with the Paschal lamb. The opulent Greeks were very fond of the lettuces of Smyrna, which appeared on their tables at the end of a feast; the Romans decided that this favourite dish should be served in the first course with eggs.

The lettuce possesses a narcotic property, of which ancient physicians have taken notice. GALEN mentions that, in his old age, he had not found a better remedy against the wakefulness he was troubled with.

Our ancestors served salads with roasted meats, roasted poultry, &c., and they had a great many which are no longer in vogue.

Lettuces, endives, watercress, beet-root, radishes, onions, and such-like, constitute the basis of the various salads, and are rendered of high nutritive value by the introduction of potatoes, haricot beans, French beans, and similar foods. In Germany, charming variety is given to salads, by making some more nutritive substance than lettuce the basis. Thus we have **bean-salad, potato-salad, herring-salad, endive-salad,** and others. The vegetables are covered with oil, acidulated with vinegar, which makes them very agreeable to the palate, and also more digestible.

Garlic was known in the most remote ages. It was a prevailing opinion that the effects of foul air were neutralized by garlic. It is called the physic of the peasantry, especially in warm countries, where it is eaten before going to work, in order to guarantee them from ill effects. The odour is intensely disagreeable, but the common experience is borne out by science. If it were made the rule that garlic should be eaten by all or none, the objection to it would cease. **Mustard** and **cress** are also not to be despised, as furnishing some variety to the breakfast and tea-table. And if only for the encouragement to be given to the cultivation of small plots of garden ground, it would be impossible too much to exalt the value of such foods. Nothing does a man greater good than a little gardening. Parsley, mustard and cress, sage, onions, thyme, and mint are easily grown; add to these lettuces, radishes, scarlet-runners, French beans, and cabbages, and already the sameness of many a man's diet vanishes.

251. Enough has been said to give the reader a general idea of the differences in fish, flesh, and fowl. We have yet to learn something as to diets in common use, and their digestibility: then alone shall we possess an adequate idea of the parts played by science and experience. No attempt has been made to give receipts for cooking, as these are to be met with in cookery books.

CHAPTER XV.

ON THE RELATIVE DIGESTIBILITY OF FOODS.

252. The conversion of vegetable food into flesh is a more difficult proceeding than the assimilation of flesh. On this account vegetable-feeders have more complicated digestive organs than those which feed on flesh alone. Thus considered, herbivorous animals may be said to prepare food for the carnivorous, or omnivorous.

253. As the bulk of the body consists of so large a proportion of water, so the solid food taken also contains more or less, but not sufficient to supply the waste: hence the necessity for drink.

254. The sources of loss are more numerous than those of supply. In fact the alimentary canal is mainly charged with the function of waste. External circumstances determine in great measure the quality and quantity of food; but the mental or bodily activity of the individual, and the temperature in which he lives, ought to be leading guides. When the temperature is high, carbonaceous foods are least required, as they are more easily productive of heat.

255. Although foods are divided into carbonaceous or respiratory, and nitrogenous or plastic, all proper nutriment contains both kinds. Without nitrogen, no nourishment can be afforded to the tissues: the carbon, hydrogen, and oxygen in the nitrogenous compound may, however, also be employed for heat as well as for nutrition. Food must be used to supply the quality of the waste, as well as the quantity. The best proportions in a mixed diet would embrace 69 parts of starch and sugar, 9 parts of fat, and 22 parts of nitrogenous material.

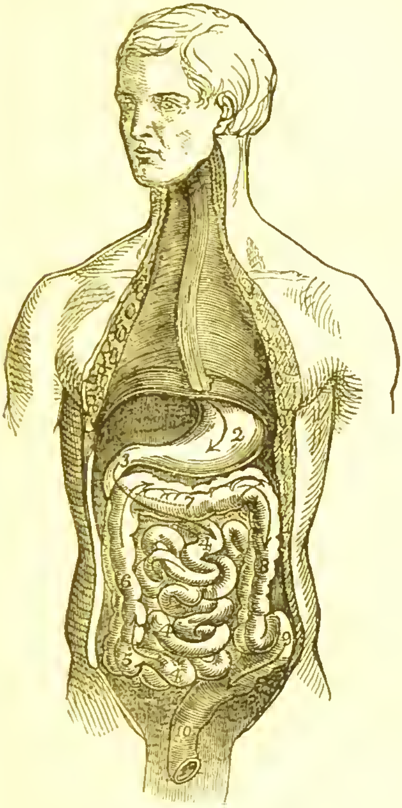
256. Even when the food is well selected, much depends upon ourselves as to the profit we shall obtain from it, as well in keeping up the heat of the body as in nourishing it. A mixed diet in moderate quantities is best suited to a healthy frame. Excess is every way injurious, both in eating and in drinking.

Unless food be properly masticated, much of it is absolutely wasted, besides being a fruitful cause of indigestion. Apart from cooking, "the early stage of preparing the food for nourishment is dependent on muscular action, and we shall find that the succeeding steps also require mechanical assistance to supplement the chemical action of solution. The stomach and intestines are, therefore, essentially muscular organs as well as organs of secretion.

"The form of the *stomach* is seen in the accompanying illustration. It is a large, sacculated cavity, capable of great distension; stretching across the upper part of the abdomen, and chiefly under the lower part of the left ribs. Its left, or *cardiac*, extremity is large, where the œsophagus terminates; its right extremity—the *pylorus*—is smaller, and guarded by a thick ring of muscular fibres and a valve of mucous membrane, so as to prevent the food during digestion from passing too soon into the intestine. The stomach has a large supply of blood-vessels, and derives its nerves from two sources.

"The mucous membrane is covered with cylindrical epithelial cells, and studded all over with the minute orifices of numberless tubular glands, some of which are branched at their extremities; it is from these that the *gastric juice*, or dissolving fluid of the stomach, is poured out at the period of digestion; and in such quantity that it has been calculated to amount, according to circumstances, to ten or fifteen pints, or even more, during twenty-four hours. But the active

ingredients in this fluid are, as in the saliva, a very small percentage of the whole, between five or six in one hundred, the remaining ninety-four parts being water. It is clear, without odour, and with very little taste. It is acid, from the presence of hydrochloric acid; but the most important and abundant constituent is called *pepsin*, in which, combined with the acid, the solvent property of the gastric juice especially resides.



ALIMENTARY CANAL (*in situ*).

1. Œsophagus.
2. Stomach.
3. Duodenum.
4. Small intestine.
5. Cæcum.
6, 7, 8. Colon.
9. Sigmoid flexure.
10. Rectum.

"The muscular action of the stomach aids this process importantly, by keeping its contents constantly moving to and fro, and thus bringing each part successively into relation with the solvent fluid; just as we should stir about anything which we wish to dissolve. In this way the food is converted into what is called *chyme*, and is then permitted to pass the pylorus into the intes-

tine."—*See* "Physiology," by F. Le Gros Clark, F.R.S., in "Manuals of Elementary Science," S.P.C.K.

257. With reference to the digestibility of food, the following Table, compiled from the well-known experiments of Dr. BEAUMONT, will afford some notion.

Relative Digestibility of Animal and Vegetable Substances.

Articles of Diet.	How cooked.	Time of Chymification. Hours.	Mins.
Pigs' feet	Boiled	1	0
Tripe	Boiled	1	0
Rice	Boiled	1	0
Eggs (whipped)	Raw	1	30
Apples (sweet)	Raw	1	30
Salmon-trout	Boiled	1	30
Venison steak	Broiled	1	30
Brains	Boiled	1	45
Sago	Boiled	1	45
Ox-liver	Broiled	2	0
Codfish (cured)	Boiled	2	0
Tapioca	Boiled	2	0
Barley	Boiled	2	0
Apples (sour)	Raw	2	0
Cabbage with vinegar	Raw	2	0
Eggs	Roasted	2	15
Turkey	Boiled	2	25
Gelatin	Boiled	2	30
Goose	Roasted	2	30
Pig	Roasted	2	30
Potatoes	Boiled	2	30
Beans	Boiled	2	30
Parsnips	Boiled	2	30
Sponge cakes	Baked	2	30
Potatoes	Baked	2	33
Chicken	Fricasseed	2	45
Beef	Boiled	2	45
Beef	Roasted	3	0
Mutton	Boiled	3	0

TABLE OF DIGESTIBILITY—*continued.*

Articles of Diet.	How cooked.	Time of Chymification Hours.	Mins.
Apple dumpling	Boiled	3	0
Indian corn cake	Baked		
Indian corn bread	Baked	3	15
Carrot	Boiled		
Mutton	Roasted		
Oysters	Stewed	3	30
Cheese	Uncooked		
Eggs	Hard-boiled		
Eggs	Fried		
Wheaten bread	Baked		
Potatoes	Boiled		
Turnips	Boiled		
Beef	Fried	4	0
Fowls	Boiled		
Fowls	Roasted		
Ducks	Roasted		
Cabbage	Boiled		
Pork	Roast	5	15
Tendon	Boiled	5	30

258. As to the necessity which exists for cooking our food, and of employing the stomachs of animals to digest for us what we ourselves cannot do, nothing more striking can be mentioned than the weights of the stomachs respectively of man, pig, sheep, and ox.

In the man, the stomach weighs			6 oz.
In the pig,	„	„	14 oz.
In the sheep,	„	„	39 oz.
In the ox	„	„	51 oz.

CHAPTER XVI.

CONCLUSION.

259. For the maintenance of robust health, nothing is equal to the "régime" adopted by men who are training for running or rowing. The basis of the system is to promote, in every way, the rapid change and renewal of every portion of the body, increasing its vital activity, and making it live fast. This is done by constant, regular and vigorous exercise, aided by baths and shampooing, to encourage the action of the skin on the one hand, and a full nourishing diet on the other. The effects on the system are truly wonderful: the muscles become large and hard; the skin clear and firm, so that it is not readily bruised; the general system becomes light and active, able to bear great exercise, not to say fatigue, and even the mind partakes of an unusual joyousness, being rendered clear and vigorous. Such rude health is perhaps rare, especially among the inhabitants of towns. There, unfortunately, we have more opportunities of seeing the effects of insufficient nutrition; exhibiting itself after a time in scrofula, scurvy, and other low forms of disease.

260. Curious experiments have been at times performed by physiologists on the effects of different kinds of nutriment in a pure state. All such experiments tend to one conclusion: that a mixed diet is necessary to health. Even albumen, the type of nourishment, is found insufficient of itself to support life. One of the most singular effects of a restricted diet seems to be, to render the stomach incapable of digesting even that little with which it is supplied.

261. Of the influence of different kinds of food on

the development of the body, there is no more curious **example** than that afforded by the history of **bees.** Every one is familiar with the vast difference between the ordinary working bee and the queen-bee; the former is simply a bee whose development in certain respects is imperfect. This difference is brought about entirely by food. If, by any accident, the queen should die, or be lost, the bees select two or three of the eggs, which they hatch in large "royal" cells, and subsequently bring up the maggot on a jelly-like, stimulating food, very different from that which they supply to their other babies.

262. The **quantity of food** required for the maintenance of the human body in health **varies** with **age, sex, constitution** and **habits of life.** The only sure **guide** is the **appetite,** provided its **dictates** are **honestly interpreted.** There can be little doubt, however, that most persons in easy circumstances eat more than is necessary, and therefore more than is good, otherwise they would not increase in bulk and weight between the ages of twenty-five and fifty. If the food is eaten slowly and thoroughly masticated, then a feeling of genial satisfaction will give a fair indication to the system to be content: beyond this, a sense of satiety is induced, which ought to warn us that the point of healthful indulgence has been exceeded.

263. With reference to the **dietaries** of large bodies of men, it is not difficult to form some general estimate of the necessary amount of food, especially after the admirable labours of Dr. Lyon Playfair and of the late Dr. Edward Smith.

The following Table of daily Dietaries of well-fed Operatives is by Playfair:—

DAILY DIETARIES OF WELL-FED OPERATIVES.

(PLAYFAIR.)

Class of Labourer.	Flesh-former.	Fats.	Starch and Sugar.	Containing		Containing	
				Carbon-aceous.	Nitro-genous.	Carbon.	Nitro-gen.
	Oz.	Oz.	Oz.	Oz.	Oz.	Grs.	Grs.
Fully-fed tailors	4·61	1·37	18·47	21·64	4·61	5,136	325
Soldiers in peace	4·22	1·85	18·69	22·06	4·22	5,246	297
Royal Engineers (work)	5·08	2·91	22·22	29·38	5·08	6,494	358
Soldiers in war	5·41	2·41	17·92	23·48	5·41	5,561	381
English sailor	5·00	2·57	14·39	20·40	5·00	4,834	252
French sailor	5·74	1·32	23·60	26·70	5·74	6,379	405
Hardworked weavers	5·33	1·53	21·89	25·42	5·33	6,020	375
English navvy (Crimea)	5·73	3·27	13·21	21·06	5·73	5,014	404
English navvy (Railway)	6·84	3·82	27·81	37·08	6·84	8,295	482
Blacksmith	6·20	2·50	23·50	29·50	6·20	6,864	437

264. In all these cases the carbonaceous matters of the food are estimated as starch. It is of first importance now to remember that **nitrogenous foods contain one-sixth of their weight of nitrogen,** and that the **relation** of the **nitrogenons** to the **carbonaceous** constituents of food should be about **one to six.** The **admixture** in the **food** of an adult should, then, be as nearly as possible **one of nitrogenous** to **six of carbonaceous.**

Dr. Playfair gives the following **Table** of **daily Diets** according to work done.

Daily Diets for	Nitrogenous.		Carbonaceous
	Oz.		Oz.
Snbsistence only	2·0	+	13·3
Qnietude	2·5	+	14·5
Moderate exercise	4·2	+	23·2
Active labonr	5·5	+	26·3
Hard work	6·5	+	26·3

For mere subsistence, for rest, and for moderate exercise, say one of nitrogenous to six of carbonaceous; for active exercise, one to five; and for hard work, one of nitrogenous to four of carbonaceous.

265. In paragraph 108 **two hundred grains of nitrogen** have been mentioned as **the least** upon which a **man** at rest, doing but little active work, **could subsist.** This really means insufficient diet. **Three hundred grains of nitrogen** would be a fair quantity for an adult man, and somewhat less for a woman.

266. According to the late Dr. Edward Smith, the following **Table** would express the **relative proportions** of food that should be taken at different meals.

	Carbon.	Nitrogen.	Carbonaceous.	Nitrogenous.
	Grains.	Grains.	Ounces.	Ounces.
For Breakfast	1,500	70	6·62	1·04
For Dinner	1,800	90	7·85	1·34
For Supper	1,000	40	4·52	0·59
Total in the Day	4,300	200	18·99	2·97

It will be observed that the amounts given are barely sufficient to support adult life.

267. A strong healthy man consumes about **two pounds** weight of **dry food** per day. If the **carbonaceous** matters be greatly **in excess** in a man's diet, **not only** is the **growth of fat** promoted, but the **nutrition** of the **tissues** is **prevented.** And if the **nitrogenous** be greatly **in excess,** then is **blood** too freely formed.

268. With reference to **drinks at meals,** it must be an **exceptional case** when the digestive organs of a **growing person require** a **stimulus,** and none such should be indulged, even in small quantities with fermented liquors, except under medical advice. The use of **weak table beer** might be allowed in places where the water was undrinkable; but, except in such cases, parents should have the strength of mind to exclude alcohol in every form from their children's diet.

Inasmuch as the flow of the saliva during a meal is of the utmost importance in digestion, liquids should not be taken in sips, but at the close. Frequent draughts stop the flow of saliva, and are therefore injurious.

269. The **atmosphere** of rooms in which we take our meals should be kept scrupulously clean. Flies and other nuisances, in summer especially, abound where cleanliness is not the first law. Nothing takes away so much from the pleasure of a social meal as a close room, and nothing is much more calculated to promote indigestion. Dustbins, and other similar contrivances for shortening life, should be as far as possible removed from our dwelling-rooms: in fact, everything that affords breeding-places of animal life.

270. **And so also from within.** If we would, humanly speaking, preserve our bodies in health, we must keep them in subjection. "A godly, righteous and sober life," as the good old Church Service has

it, is greatly promotive of health, and has much to do with that happy condition of unconsciousness as to the existence of the body which is the very perfection of our animal life.

"Send portions unto them for whom nothing is prepared," and "be given to hospitality," are directions in no-wise to be disregarded. Certainly they are a great encouragement to cheerfulness, which is also an aid to proper nutrition. Above all things, let us praise Him who "knoweth our frame, and remembereth that we are but dust." The carbon and the nitrogen are simply instruments in His hands. When He withholds, neither does the nitrogen repair, nor the carbon and hydrogen heat.

"The eyes of all wait upon Thee, and Thou givest them their meat in due season. Thou openest Thine hand, and satisfiest the desire of every living thing."

THE END.

INDEX.

THE END.

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